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4 AND 5th OCTOBER 1979 — 4 EN 5 OKTOBER 1979
PALMS HOTEL PRETORIA PALMS—HOTEL

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Symposium presented by the Atomic Energy Board and the Department of Agricultural Technical Services, at the Palms Hotel, Silverton, Pretoria, from 3rd October to 5th October 1979.

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NATIONAL SYMPOSIUM

ON

FOOD IRRADIATION

organised by
The South African Atomic Energy Board
and
The Department of Agricultural Technical Services

Palms Hotel
Pretoria Road
Silverton
PRETORIA

3 – 5 October 1979

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ACKNOWLEDGEMENTS

The organisers and members of the organising committee wish to extend their grateful appreciation to the following organisations listed below in alphabetical order for their support of the symposium:

Bull Brand Foods (Pty) Ltd

Distillers Corporation (SA) Ltd

Mr A Du Venage, Glenwood Farms

Farm Fare (Pty) Ltd

Intercontinental Beer Sales

Letaba Cooperative Ltd

Lilroy Prepak (Pty) Ltd

Meat Board

Mr G A Solomon, Haakdoornboom

Tongaat Mushrooms, Tvl, (Pty) Ltd

Total SA (Pty) Ltd

The organisers wish to express their sincere gratitude to authors, session chairmen and other office bearers, as well as the staff of the AEB for their time and effort devoted to the symposium.

OFFICE BEARERS

Main Organisers:	Dr W J de Wet (Atomic Energy Board) and Dr J C Strydom (Department of Agricultural Technical Services)
Symposium Chairman:	Dr W J de Wet – Atomic Energy Board
Symposium Secretary:	Mrs D Bosch
Planning Committee:	Dr H T Brodrick (Coordinator) Dr W C A van Niekerk Miss M Beyers Mrs D Naude Mr A J van Tonder
Session Chairman:	Dr J G Boyazoglu – SA Embassy, Paris (Agricultural Section) Dr W J de Wet – AEB Dr J H Lombard – Meat Board Dr H J van der Linde – AEB Mr P Vermaak – Letaba Cooperative
Panel Discussion Chairman:	Dr P S Elias – Director, International Food Irradiation Project

NASIONALE SIMPOSIUM

OOR

VOEDSELBESTRALING

gereël deur die
Suid-Afrikaanse Raad op Atoomkrag
en
Die Departement van Landbou-Tegniese Dienste

Palms-hotel
Pretoriaweg
Silverton
Pretoria

3 – 5 Oktober 1979

INHOUD

BEDANKINGS

Die organiseerders en lede van die beplanningskomitee is dank verskuldig aan ondergenoemde organisasies, alfabeties gerangskik, vir steun aan die simposium verleen.

Bull Brand Foods (Edms) Bpk

Distillers Korporasie (SA) Bpk

Mnr A Du Venage, Glenwood Farms

Farm Fare (Edms) Bpk

Interkontinentale Bierverkope

Lilroy Prepak (Edms) Bpk

Mnr G A Solomon, Haakdoornboom

Letaba Koöperasie Bpk

Tongaat Mushrooms Tvl (Edms) Bpk

Total SA (Edms) Bpk

Vleisraad

Die organiseerders is ook veel dank verskuldig aan die sprekers, sessievoorsitters en ander ampsdraers, asook personeel van die RAK, vir die tyd en moeite wat aan die simposium bestee is.

AMPSDRAERS

Hooforganiseerders:	Dr W J de Wet (Raad op Atoomkrag) en Dr J C Strydom (Dept. van Landbou-Tegniese Dienste)
Simposiumvoorsitter:	Dr W J de Wet, Raad op Atoomkrag
Simposiumsekretaresse:	Mev D Bosch
Beplanningskomitee:	Dr H T Brodrick (Sameroeper) Dr W C A van Niekerk Mej M Beyers Mev D Naude Mnr A J van Tonder
Sessievoorsitters:	Dr J G Boyazoglu — SA Ambassade, Parys (Afdeling Landbou) Dr W J de Wet — RAK Dr J H Lonbard — Vleisraad Dr H J van der Linde — RAK Mnr P Vermaak — Letaba Koöperasie
Paneelbesprekingsvoorsitter:	Dr P S Elias — Direkteur van die Internasionale Voedselbestralingsprojek

GENERAL INFORMATION

REGISTRATION

Registration will take place from 08h00 to 09h00 on Thursday 4 October and from 08h00 to 08h30 on Friday 5 October 1979 in the adjoining lounge to the Symposium Hall at the Palms Hotel. Participants will receive a list of delegates, copies of extended abstracts of papers to be presented and other relevant information, as well as a name tag which should be worn at all times.

DISCUSSIONS

Approximately five minutes per paper will be allocated for discussions.

TRANSPORT

A free bus service will operate daily between the appointed hotels and the symposium venue. The departure times are listed below:

THURSDAY, 4 October 1979

07h30 Depart from Boulevard Hotel for Burgerspark Hotel
07h40 Depart from Burgerspark Hotel for Oklahoman Motor Hotel
08h05 Depart from Oklahoman Motor Hotel for Palms Hotel

19h45 Depart from Palms Hotel for Oklahoman Motor Hotel, Burgerspark Hotel and Boulevard Hotel

FRIDAY, 5 October 1979

07h30 Depart from Boulevard Hotel for Burgerspark Hotel
07h40 Depart from Burgerspark Hotel for Oklahoman Motor Hotel
08h05 Depart from Oklahoman Motor Hotel for Palms Hotel

17h00 Depart from Palms Hotel for Oklahoman Motor Hotel, Burgerspark Hotel and Boulevard Hotel

ALGEMENE INLIGTING

REGISTRASIE

Registrasie vind plaas op Donderdag 4 Oktober 1979 tussen 03h00 en 09h00 en op Vrydag 5 Oktober 1979 tussen 08h00 en 08h30 in die sitkamer langs die simposiumsaal in die Palms-hotel. By registrasie sal elke afgevaardigde 'n omslag ontvang met 'n lys van die afgevaardigdes, afdrukke van opsommings van die referate wat gelewer word, ander verwante inligting, asook 'n naamkaartjie wat tydens die simposium gedra moet word.

BESPREKINGS

Ongeveer 5 minute sal per lesing vir bespreking uit die gehoor toegelaat word.

VERVOER

Gratis busvervoer vanaf die aangewysde hotelle na die simposiumlokaal en terug sal daagliks verskaf word. Die vertrektye is soos volg:

DONDERDAG 4 Oktober 1979

07h30 Vertrek van Boulevard-hotel na Burgerspark-hotel
07h40 Vertrek van Burgerspark-hotel na Oklahoman-motel
08h05 Vertrek van Oklahoman-motel na Palms-hotel
19h45 Vertrek van Palms-hotel na Oklahoman-motel, Burgerspark-hotel en Boulevard-hotel

VRYDAG 5 Oktober 1979

07h30 Vertrek van Boulevard-hotel na Burgerspark-hotel
07h40 Vertrek van Burgerspark-hotel na Oklahoman-motel
08h05 Vertrek van Oklahoman-motel na Palms-hotel

17h00 Vertrek van Palms-hotel na Oklahoman-motel, Burgerspark-hotel en Boulevard-hotel

VISIT TO PELINDABA ON WEDNESDAY, 3 OCTOBER 1979

As part of the symposium, delegates will be afforded the opportunity of visiting the Nuclear Research Centre at Pelindaba where a guided tour will include, amongst others, the food irradiation facility and the radiation sterilisation plant. The visit can be arranged either for the morning (08h30 – 12h00) or the afternoon (13h00 – 16h30) depending on the number of persons involved. Transport will be available from Pretoria. Departure times for buses are listed below:

Morning

07h10 Depart from Palms Hotel for Oklahoman Motor Hotel
07h20 Depart from Oklahoman Motor Hotel for Burgerspark Hotel
07h45 Depart from Burgerspark Hotel for Boulevard Hotel
07h55 Depart from Boulevard Hotel for Pelindaba

12h00 Depart from Pelindaba for the above hotels

Afternoon

11h40 Depart from Palms Hotel for Oklahoman Motor Hotel
11h50 Depart from Oklahoman Motor Hotel for Burgerspark Hotel
12h15 Depart from Burgerspark Hotel for Boulevard Hotel
12h25 Depart from Boulevard Hotel for Pelindaba

16h30 Depart from Pelindaba for the above hotels

SOCIAL FUNCTION

Cocktail Party – Thursday, 4 October 1979 from 17h45 to 19h45.

BRIEFING SESSION FOR AUTHORS AND CHAIRMEN

Authors and chairmen for the relevant days are kindly requested to attend the briefing sessions which will take place between 08h15 and 08h30 on both Thursday 4 and Friday 5 October 1979.

EXHIBITION

A number of irradiated food items will be on display in the Symposium Hall.

TELEPHONES

Prior to the symposium

Pretoria (012) 794441 x301 (Mrs D Bosch)
Telex 3-0253 SA

During the Symposium

Pretoria (012) 86-1014
Telex 3-0307 SA

BESOEK AAN PELINDABA OP WOENSDAG 3 OKTOBER 1979

As 'n gedeelte van die simposium sal afgevaardigdes die geleentheid gebied word om die Kernnavorsingsentrum te Pelindaba te besoek. Die voedselbestralingsfasiliteit en die stralingsteriliseeraanleg sal, onder andere, met 'n begeleide toer besoek word. Die besoek kan òf gedurende die voormiddag (08h30 – 12h00) òf die namiddag (13h00 – 16h30) gereël word, afhangende van die getal persone daarby betrokke. Vervoer sal vanaf Pretoria beskikbaar gestel word.

Vertrektye vir busse is soos volg:

Oggend

07h10 Vertrek van Palms-Hotel na Oklahoman-motel
07h20 Vertrek van Oklahoman-motel na Burgerspark-hotel
07h45 Vertrek van Burgerspark-hotel na Boulevard-hotel
07h55 Vertrek van Boulevard-hotel na Pelindaba

12h00 Vertrek van Pelindaba na bogenoemde hotelle

Middag

11h40 Vertrek van Palms-hotel na Oklahoman-motel
11h50 Vertrek van Oklahoman-motel na Burgerspark-hotel
12h15 Vertrek van Burgerspark-hotel na Boulevard-hotel
12h25 Vertrek van Boulevard-hotel na Pelindaba

16h30 Vertrek van Pelindaba na bogenoemde hotelle

SOSIALE BYEENKOMS

Skemeronthaal – Donderdag, 4 Oktober 1979 vanaf 17h45 tot 19h45.

VOORLIGTINGSESSIES VIR SPREKERS EN VOORSITTERS

Sprekers en voorsitters word vriendelik versoek om die voorligtingsessies by te woon wat tussen 08h15 en 08h30 op beide Donderdag 4 Oktober en Vrydag 5 Oktober 1979 gehou sal word.

UITSTALLING

'n Aantal bestraalde voedselsoorte sal in die simposiumlokaal uitgestal word.

TELEFONE

Voor die simposium

Pretoria (012) 79 4441 x 301 (Mev D Bosch)
Teleks 3-0253SA

Gedurende die simposium

Pretoria (012) 86-1014
Teleks 3-0307SA

PROGRAM

WEDNESDAY 3 OCTOBER

VISIT TO PELINDABA

THURSDAY 4 OCTOBER

OPENING

09h05 – 09h25	Introduction by Symposium Chairman: Dr W J de Wet (Atomic Energy Board) Welcoming address: Dr J P Hugo (Deputy President, Atomic Energy Board)
09h25 – 09h45	Opening address: Dr D W Immelman (Secretary, Department of Agricultural Technical Services): General introduction on new technologies in agriculture and food supply
09h45 – 09h50	Dr J P Hugo introduces dr P S Elias, Director, International Food Irradiation Project (IFIP)
09h50 – 10h45	Dr P S Elias (International Food Irradiation Project, West Germany): The aims and achievements of the International Food Irradiation Project.
10h45 – 11h05	TEA

SESSION 1: GENERAL BACKGROUND

Chairman:	Dr H J van der Linde (Atomic Energy Board)
11h05 – 11h30	Dr P G Marais (Fruit and Fruit Technology Research Institute, Stellenbosch): The development of South Africa's Food Irradiation Program
11h30 – 11h55	Miss M Beyers (Atomic Energy Board): The influence of radiation on the chemical constituents of food
11h55 – 12h20	Mr J G Niemand (Atomic Energy Board): The influence of radiation on micro-organisms with reference to meat
12h20 – 12h45	Dr H T Brodrick (Atomic Energy Board): The influence of radiation on plant micro-organisms with reference to fruit and vegetables.
12h45 – 14h15	LUNCH

SESSION 2: MEAT

Chairman:	Dr J H Lombard (Meat Board, Pretoria)
14h20 – 15h05	Dr A Brynjolfsson (Natick, USA): Radappertisation of meats
15h05 – 15h30	Dr P S Elias (IFIP, West Germany): The status of fish and poultry irradiation in the world
15h30 – 15h50	TEA
15h50 – 16h15	Dr R T Naudé (Animal and Dairy Science Research Institute, Irene): Problems, practices and prospects of the red meat industry of South Africa
16h15 – 16h40	Prof L W van den Heever (Faculty of Veterinary Science, University of Pretoria): Irradiation of edible food animal offal
16h40 – 17h05	Dr A Verster*, T A du Plessis and L W van den Heever (* Veterinary Research Institute, Onderstepoort): The effect of gamma radiation on the larval stages of tapeworm
17h05 – 17h30	Mr W O Stiekema (Farm Fare (Pty) Ltd, Sandton): Problems in the broiler poultry industry
17h45 – 19h45	COCKTAIL PARTY

PROGRAM

WOENSDAG 3 OKTOBER

Besoek aan Pelindaba

DONDERDAG 4 OKTOBER

OPENING

09h05 – 09h25 Inleiding deur Simposiumvoorsitter: Dr W J de Wet (Raad op Atoomkrag)
Dr J P Hugo (Adjunk-president, Raad op Atoomkrag)

09h25 – 09h45 Openingsrede: Dr D W Immelman (Sekretaris, Departement van Landbou-Tegniese Dienste): General introduction on new technologies in agriculture and food supply

09h45 – 09h50 Dr J P Hugo stel dr P S Elias, Direkteur van die Internasionale Voedselbestralingsprojek, voor

09h50 – 10h45 Dr P S Elias (Internasionale Voedselbestralingsprojek, Wes-Duitsland): The aims and achievements of the International Food Irradiation Project

10h45 – 11h05 TEE

SESSIE 1: ALGEMENE AGTERGROND

Voorsitter: Dr H J van der Linde (Raad op Atoomkrag)

11h05 – 11h30 Dr P G Marais (Navorsingsinstituut vir Vrugte en Vrugtetegnologie, Stellenbosch): The development of South Africa's Food Irradiation Program

11h30 – 11h55 Mej M Beyers (Raad op Atoomkrag): The influence of radiation on the chemical constituents of food

11h55 – 12h20 Dr J G Niemand (Raad op Atoomkrag): The influence of radiation on micro-organisms with reference to meat

12h20 – 12h45 Dr H T Brodrick (Raad op Atoomkrag): The influence of radiation on plant micro-organisms with reference to fruit and vegetables

12h45 – 14h15 MIDDAGETE

SESSIE 2: VLEIS

Voorsitter: Dr J H Lombard (Vleisraad, Pretoria)

14h20 – 15h05 Dr A Brynjolfsson (Natick, VSA): Radappertisation of meats.

15h05 – 15h30 Dr P S Elias (Internasionale Voeselbestralingsprojek, Wes-Duitsland): The status of fish and poultry irradiation in the world

15h30 – 15h50 TEE

15h50 – 16h15 Dr R T Naudé (Navorsingsinstituut vir Vee- en Suiwelkunde, Irene): Problems, practices and prospects of the red meat industry of South Africa

16h15 – 16h40 Prof L W van den Heever (Fakulteit Veeartsenykunde, Univ. van Pretoria): Irradiation of edible food animal offal

16h40 – 17h05 Dr A Verster*, T A du Plessis en L W van den Heever (*Navorsingsinstituut vir Veeartsenykunde, Onderstepoort): The effect of gamma radiation on the larval stages of tapeworm

17h05 – 17h30 Mr W O Stiekema (Farm Fare (Edms) Bpk, Sandton): Problems in the broiler poultry industry

17h45 – 19h45 SKEMERPARTY

FRIDAY 5 OCTOBER

SESSION 1: AGRICULTURAL PRODUCTS

Chairman: Dr J G Boyazoglu (SA Embassy, Paris)

08h30 – 09h00 Dr J H Grobler (Citrus and Subtropical Fruit Research Institute, Nelspruit): Fruit production in South Africa

09h00 – 09h25 Mr E Strydom and A C Jandrell (Department of Agricultural Technical Services, Pretoria): Vegetable and potato production in South Africa

09h25 – 09h50 Mr P J Wessels (Department of Agricultural Economics and Marketing, Pretoria): Quantitative and qualitative aspects of agricultural products

09h50 – 10h10 Mr O J la Grange (Department of Commerce and Consumer Affairs, Pretoria): South Africa as an export supplier of agricultural products

10h10 – 10h30 TEA

SESSION 2: MARKETING

Chairman: Mr P Vermaak (Letaba Cooperative, Tzaneen)

10h30 – 10h55 Dr P N Swanepoel (Department of Health, Pretoria): Regulatory aspects of irradiated food

10h55 – 11h20 Dr H J van der Linde and H T Brodrick (Atomic Energy Board): Organisation of market testing of irradiated food in South Africa

11h20 – 11h45 Dr H T Brodrick and H J van der Linde (Atomic Energy Board): Market testing of irradiated food in South Africa

11h45 – 12h10 Mr N Webb (OK Bazaars, Johannesburg): Retailer response to food irradiation

12h10 – 13h45 LUNCH

SESSION 3: RADIATION FACILITIES – COSTS AND PLANT DESIGN

Chairman: Dr W J de Wet (Atomic Energy Board)

13h45 – 14h25 Dr A Brynjolfsson (Natick, USA): Energy requirements and costs of radiation processing

14h25 – 14h45 Dr T A du Plessis (Atomic Energy Board): The techno-economic aspects of gamma-radiation processing

14h45 – 15h05 Mr R Lunt (Letaba Cooperative, Tzaneen): The operation of a pilot plant pool facility

15h05 – 15h25 TEA

15h25 – 16h40 PANEL DISCUSSION

Chairman: Dr P S Elias (IFIP, West Germany)

Dr P S Elias – Wholesomeness aspects; Dr P N Swanepoel – Health and legal aspects; Dr W J de Wet – Precommercial phase and radiation facilities; Dr A Brynjolfsson – Meat, poultry, fish, etc.; Dr J H Grobler – Fruits; Dr H J van der Linde – Miscellaneous commodities.

16h40 – 16h50 Closing remarks: Dr J W L de Villiers (President, Atomic Energy Board)

PLEASE NOTE:
Due to the uncertainty of Dr Brynjolfsson's participation, substitute papers may be read.

VRYDAG 5 OKTOBER

SESSIE 1: LANDBOUPRODUKTE

Voorsitter:	Dr J G Boyazogiu (SA Ambassade, Parys)
08h30 – 09h00	Dr J H Grobler (Navorsingsinstituut vir Sitrus en Subtropiese Vrugte, Nelspruit): Fruit production in South Africa
09h00 – 09h25	Mnre E Strydom en A C Jandrell (Dept. van Landbou-Tegniese Dienste, Pretoria): Vegetable and potato production in South Africa
09h25 – 09h50	Mnr P J Wessels (Dept. van Landbou-Ekonomie en Bemarking, Pretoria): Quantitative and qualitative aspects of agricultural products
09h50 – 10h10	Mnr O J la Grange (Dept. van Handel en Verbruikersake, Pretoria): South Africa as an export supplier of agricultural products
10h10 – 10h30	TEE

SESSIE 2: BEMARKING

Voorsitter:	Mnr P Vermaak (Letaba Koöperasie, Tzaneen)
10h30 – 10h55	Dr P N Swanepoel (Departement van Gesondheid, Pretoria): Regulatory aspects of irradiated food
10h55 – 11h20	Drr H J van der Linde en H T Brodrick (Raad op Atoomkrag): Organisation of market testing of irradiated food in South Africa
11h20 – 11h45	Drr H T Brodrick en H J van der Linde (Raad op Atoomkrag): Market testing of irradiated food in South Africa
11h45 – 12h10	Mnr N Webb (OK Bazaars, Johannesburg): Retailer response to food irradiation (OK Bazaars)
12h10 – 13h45	MIDDAGETE

SESSIE 3: BESTRALINGSFASILITEITE – KOSTE EN AANLEGONTWERP

Voorsitter:	Dr W J de Wet (Raad op Atoomkrag)
13h45 – 14h25	Dr A Brynjolfsson (Natick, VSA): Energy requirements and costs of radiation processing
14h25 – 14h45	Dr T A du Plessis (Raad op Atoomkrag): The techno-economic aspects of gamma-radiation processing
14h45 – 15h05	Dr R Lunt (Letaba Koöp. Bpk, Tzaneen): The operation of a pilot plant pool facility
15h05 – 15h25	TEE
15h25 – 16h40	PANEELBESPREKINGS
Voorsitter:	Dr P S Elias (Internasionale Voedselbestralingsprojek, Wes-Duitsland)

Dr P S Elias – Voedsaamheidsaspekte; Dr P N Swanepoel – Gesondheids- en wetsaspekte; Dr W J de Wet – Voorkommersiële fase en bestralingsfasiliteite; Dr A Brynjolfsson – Vleis, hoenders, vis, ens.; Dr J H Grobler – Vrugte; Dr H J van der Linde – Diverse items.

16h40 – 16h50 Slotopmerkings: Dr J W L de Villiers (President, Raad op Atoomkrag)

NEEM ASB KENNIS:
Weens onsekerheid oor die deelname van Dr Brynjolfsson kan ander referate ter vervanging gelewer word.

ZA7900250

THE AIMS AND ACHIEVEMENTS OF THE FOOD IRRADIATION PROJECT

by
P S ELIAS
Project Director, International Food Irradiation Project,
Karlsruhe, West Germany

By the end of the 1960's, interest in food irradiation was being expressed in many different countries and a large number of food items were being considered for treatment. Because of the potential importance of the process, the cost of biological tests and the danger of unnecessary duplication of effort, international collaboration on food irradiation became highly desirable.

After detailed discussions between the Joint FAO/IAEA Division of Atomic Energy in Food and Agriculture, the NEA and interested countries, the International Food Irradiation Project (IFIP) was set up in October 1970. Organisations in 19 countries signed the agreement to set up a project for 5 years. Since then, extensions have been granted, firstly from 1975 to 1978, and then from 1978 to 1981 and the membership has grown to 25 countries.

Project Administration

IFIP is supported by contributions from the participating organisations. The participants can choose between two levels of contribution depending on the extent to which they wish to exercise control over the project's activities. An annual contribution of not less than US $5 000 is required for participation and this entitles the member country to send a representative to the Board of Management. Countries contributing US $25 000 or more are also entitled to individual representation on the Scientific Program Committee (SPC). Participants paying US $5 000 have organised themselves into groups, each of which is represented by one delegate at the SPC. As an alternative to financial contributions, participants may offer supplies or services required by the project at a suitably reduced cost.

The Federal German authorities, in addition to their financial contribution, generously provide the host centre facilities free of charge. These include offices, laboratories and the services of the Project Director's secretary and a laboratory assistant. The salary and expenses of the Project Director are provided by the IAEA and those of the secretary by the OECD.

Objectives of the Project

The tasks of IFIP were defined in 1970 and although some reorientation of these aims has occurred, they are basically still valid today.

1) Wholesomeness testing of irradiated foods
2) Research on and investigations into the methodology of wholesomeness testing
3) Dissemination of information resulting from the work undertaken and other information concerning wholesomeness testing of relevance to the program
4) Assisting national and international authorities in their consideration of the acceptance of irradiated food.

It should be stressed that the basic function of this project has always been to facilitate the objective evaluation of the wholesomeness of irradiated foodstuffs. It is not concerned with promoting the use of the process or with assessing or improving its economic feasibility.

Wholesomeness Testing

As a first priority, studies were initiated on irradiated potatoes, wheat and wheat products which had been recommended a temporary (5 years) clearance in 1969 by a Joint FAO/IAEA/WHO Expert Committee. Additional foodstuffs were chosen on the basis of four factors:

a) Interest in the product as a staple food entering into international trade;
b) The interests of developing countries;
c) The extent to which the product lends itself technically and economically to irradiation treatment;
d) The desirability of giving priority to products to be irradiated at low or medium doses.

The products chosen included fish, rice, spices, mangoes, dates and onions.

In none of these studies was any significant effect observed which could be atrributed to the feeding of irradiated food.

Methodology Research

A large number of wholesomeness studies carried out in the 1950's, using protocols which were then considered adequate. were by 1964, regarded as incomplete and unacceptable. To avoid the recurrence of such problems, IFIP has devoted considerable attention to reviewing and up-dating its testing procedures. A continuous study of the scientific literature and the publications of regulatory bodies has been linked with practical research work in IFIP's laboratory and consultation with many experts in toxicology.

The results of this work are reflected in the careful design of the project's animal feeding studies and in a diversification of the testing methods used. In the project's own laboratory, the effects of irradiated food on the immune system of the rat have been studied and several genetic tests using cultured mammalian cells have been employed. In recent years, the advent of a number of simple, short-term and highly sensitive tests for mutagenicity has opened up new possibilities for the detection of possible genetic effects of irradiated foods. The project has investigated these new test systems and has adapted them where necessary to its own specific requirements. A comprehensive program of mutagenicity testing, involving many different methods, and carried out in the Project Laboratory and elsewhere under contract, is underway at present.

Since the effects of radiation on a foodstuff depend on its composition and structure, the changes occurring in closely related types of products would be expected to be similar. The biological effects, if any, of irradiated foodstuffs of similar composition, e.g. different types of grain, or lean meat from different species of animal, would therefore be expected to be comparable. However, no two foodstuffs are identical in composition and in order to prove the validity of extrapolating the results of wholesomeness tests, it has been necessary to study in some detail the chemical changes induced in different foodstuffs by irradiation. IFIP has commissioned very little practical work in this field but has engaged expert consultants to write reviews on many aspects of radiation chemistry and through its Coordinated Program on the Radiation Chemistry of Food and Food Components has organised meetings and discussions.

A large body of data on the radiation chemistry of foods has now been collected which is of great value not only in assisting extrapolation, but also in its own right. The identification and measurement of chemical substances produced in foods after irradiation is extremely useful in assessing the possible health hazards of consuming irradiated foods.

Information Activities

The results of scientific investigations sponsored by IFIP are published in Project Technical Reports which now number over 50. Information of more general interest, including reviews and reports from other organisations is published in the project bulletin "Food Irradiation Information" which appears at approximately yearly intervals and is distributed throughout the world.

In addition, the project's Information Section stores and collates reports published in the field of food irradiation and is at present involved in processing for computer storage much of the earlier published information which has not previously been available in this form.

Assistance to National and International Authorities

It is not the function of IFIP to judge the acceptability of irradiated foods. However, when requested by the national and regulatory bodies responsible for such decisions, IFIP is always willing to provide information and advice.

ZA79002S1

THE DEVELOPMENT OF SOUTH AFRICA'S FOOD IRRADIATION PROGRAM

by
P G MARAIS
Fruit and Fruit Technology Research Institute, Stellenbosch

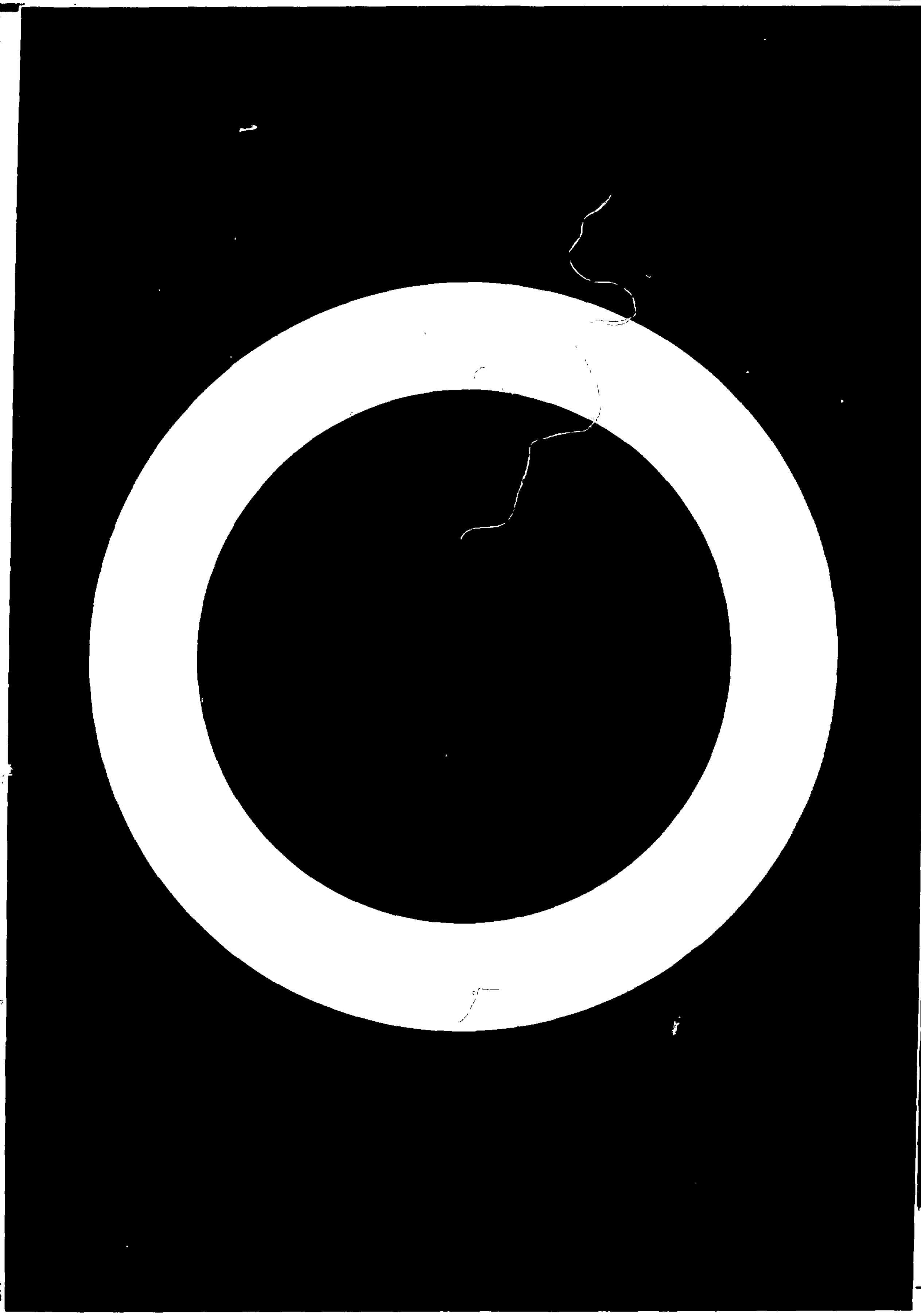
The first experiments on irradiation preservation of food in South Africa were conducted at the Fruit and Fruit Technology Research Institute in Stellenbosch, using a cobalt-60 irradiation unit which was installed in July 1961. Attention was given to apples, grapes, peaches, fruit juices and potatoes. The results were sufficiently promising to warrant further research and in 1970 a joint program was initiated between the Atomic Energy Board (AEB) and the Department of Agricultural Technical Services (ATS). This program is currently being executed at Pelindaba. South Africa has since 1971 also participated together with 23 other countries in the International Food Irradiation Project (IFIP) under the auspices of the World Health Organisation, the Organisation of Economic Co-operation and Development and the International Atomic Energy Agency.

An extremely important aspect of the food irradiation project is to prove that the irradiated product is safe for consumption and to convince the Health Authorities and the consumer of this. Most of the work in this connection is covered by the IFIP-programme. However, a short-term feeding study was undertaken at Onderstepoort on irradiated mangoes, while at Pelindaba there has been an investigation into the concept of using a simple aqueous solution model to predict the chemical changes which take place when fruits are irradiated.

The research program at Pelindaba has already yielded extremely valuable practical results with subtropical fruit such as mangoes, papayas, avocados and litchis. Many other products also received attention, such as chicken, meat, mushrooms, potatoes, onions, garlic and strawberries. The work included simulated storage and shipment, as well as actual shipment, all of which proved very successful. A pilot plant was also erected jointly with the Letaba Cooperative at Tzaneen in 1977 bringing the use of ionising radiation for food preservation much closer to commercial applications.

The Department of Health has been closely involved with all these developments and has kept fully in touch with international progress in this field. In January 1977, irradiated potatoes were unconditionally cleared for sale in South Africa. Since then several other products have been cleared and irradiated papayas, mangoes, strawberries, dried bananas and garlic have already been sold to the public. Consumers reacted very favourably and irradiated food is already being associated with quality. The improvement in the quality of the product or its increased shelf life more than warrants the additional cost involved by radiation.

Progress in all the above areas is closely scrutinised by a National Subcommittee on which many outside people, including persons from ATS, are members. More recently, a Coordinating Committee has been formed which is responsible for the overall planning of the program.



THE INFLUENCE OF RADIATION ON THE CHEMICAL CONSTITUENTS OF FOOD

by
M BEYERS
Chemistry Division Atomic Energy Board

Fats, carbohydrates, proteins, vitamins, minerals and water are the six major components necessary in an adequate diet. Energy is derived from the first three constituents although the main functions of proteins are in structural and regulatory capacities. Vitamins, minerals and water are essential in maintaining correct metabolic processes in the living organism.

All food processing methods cause physical and chemical changes in the foodstuffs. Foods are composed of a vast array of constituents. These constituents have a marked effect on each other during food processing. Food preservation techniques should cause minimum change in the composition of the foodstuffs.

Wholesomeness evaluation of gamma-irradiated food may be divided into two categories:
(i) The monitoring of any change in nutritional content.
(ii) The examination of the possible formation of toxic degradation products.

These investigations take the form of animal feeding studies or chemical monitoring. Model compounds or the actual foodstuffs are used. The changes produced by irradiation are greater in the model components than in the whole food. Some model compounds, e.g. sugar solutions, are toxic *in vitro* but the toxicity could not be detected *in vivo*. Actual sugar containing foods do not exhibit this phenomenon of *in vitro* toxicity.

Ionising irradiation differs from conventional irradiation techniques, such as thermal processing, only in the type of energy employed. Changes brought about by heat and ionising radiation differ in quantity rather than quality with the cold process of ionising radiation being far less abusive than heating. With the irradiation doses recommended for commercial food processing, the concentration of the most abundant radiolytic substances is confined to the ppm range.

Very few foods do not have water as a significant component. Gamma rays are able to excite and ionise molecules along their path in an indiscriminate manner. More water molecules will therefore be affected than other components of the food. There is no significant decrease in the water content during the process but the reaction products formed from the water are highly reactive and these attack the other constituents of the food. In foodstuffs with a limited water content the photons will react directly with the food. The major radiolytic products of water are hydroxyl radicals and hydrated electrons. Hydroxyl radicals are rather unselective so that their targets are principally the components present in excess i.e. carbohydrates, fats or proteins depending on the type of food being treated. Thus the major components tend to "protect" those present in lower concentrations. Hydrated electrons are more specific in their action and attack compounds with low lying vacant orbitals. They do not react to any extent with carbohydrates and only with certain amino acids present in proteins. Minor components such as vitamins can therefore react with hydrated electrons.

The degradation products of lipids caused by ionising radiation, autoxidation and thermal processing are very similar. Degradation of lipids by any process yields a large variety of compounds depending on the composition of the lipid. No untoward effects have been noted in laboratory animals fed irradiated lipid-containing foods such as chicken, beef, cod or mackeral.

Degradation of polysaccharides by ionising radiation yields simpler carbohydrates. Feeding irradiated potatoes and dry maize starch to rats had no deleterious effects on the animals. Sugars, i.e. simpler carbohydrates, are not significantly degradated by commercially recommended doses of ionising radiation. Most of the radiolytic products are carbonylic in character. Products formed in irradiated fruits and vegetables have been shown to be non-toxic.

No significant changes could be detected in the nutritiousness of a variety of proteins. The amino acid composition remained unchanged. A small quantity, ppb, of volatile components are formed during the irradiation of meats.

Vitamins are radiation sensitive but a number of them are also heat-labile. Thiamin and vitamin E are most readily affected by irradiation but losses are slight. No vitamin deficiency diseases could be detected in laboratory animals receiving irradiated fruits and vegetables.

Minerals are unaffected, nutritionally, by ionising radiation. Iron II is oxidised to Iron III but this compound is efficiently reduced during digestion. Iron has a sensitising effect on the radiation degradation of ascorbic acid but the concentration of this mineral is usually too low for this effect to be significant.

At present more is known about the effects of ionising radiation on foodstuffs than about other more conventional processing methods with ionising radiation appearing to be the milder process.

THE INFLUENCE OF RADIATION ON MICRO-ORGANISMS WITH REFERENCE TO MEAT

by
J G NIEMAND
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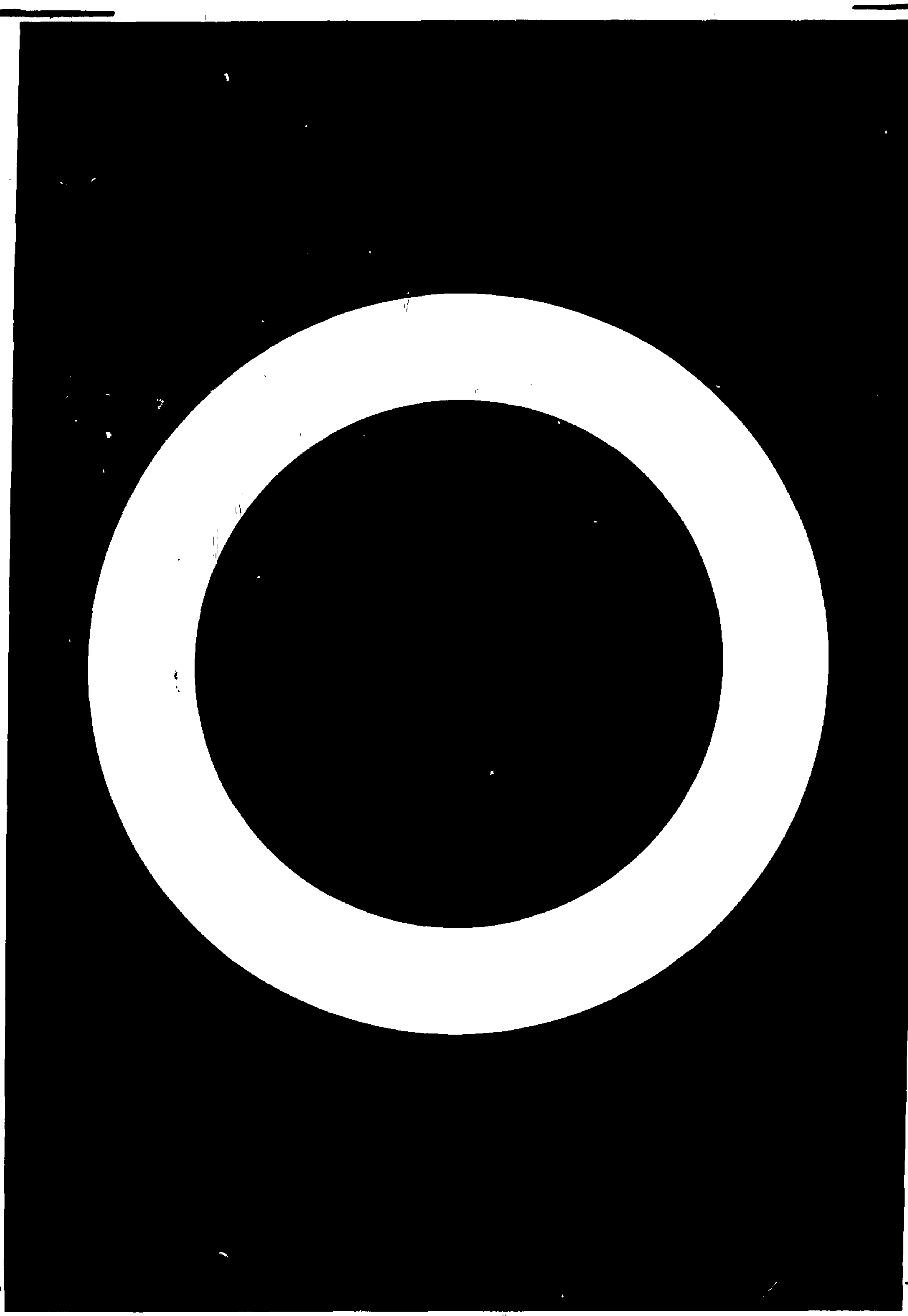
The bactericidal effects of ionising radiation was studied as early as 1896, shortly after the discovery of X-rays by Von Roentgen. Continued investigations over the past 80 years into the biological effects of ionising radiation confirmed its lethal effects, as well as the potent mutagenic action on all living organisms. The DNA molecules inside the living cell are the prime target for the radiation energy, either through direct reaction with it or through its reaction with other molecules affected by radiation.

A broad spectrum of micro-organisms exists with regard to radiation sensitivity. Spore forming bacteria are as a rule very radiation-resistant, e.g. *Clostridium botulinum*, although exceptions such as *Micrococcus radiodurans* and *Moraxella-Acinetobacter* exist. The survival mechanism for these non-sporeforming bacteria seems to be the possession of an ultra-effective DNA repair capacity.

The first meaningful attempt at using ionising radiation for food preservation was in 1943 when Proctor, van de Graaff and Fram reported their work on preservation of hamburger meat, using X-rays. The limited storage life of refrigerated meat is caused mainly by the presence of large numbers of spoilage bacteria, e.g. *Pseudomonas*, in the meat, growing at temperatures as low as 4 °C. These bacteria are most sensitive to radiation so that a considerable extension of shelf life can be attained with low-dose applications of ionising radiation – *radurisation*. Food-poisoning bacteria such as *Salmonella* can also be eliminated from meat at relatively low doses – *radicidation*, resulting in a product of high keeping – and hygienic quality. Application of high doses results in sterilisation of meat, and a product with a shelf life of several years when stored at room temperature – *radappertisation*.

With the above objectives in mind, meat – a product with a very high unit cost and of a highly perishable nature – therefore seems to be an ideal food to benefit from irradiation.



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THE INFLUENCE OF RADIATION ON PLANT MICRO-ORGANISMS WITH REFERENCE TO FRUIT AND VEGETABLES

by
H T BRODRICK
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The spoilage by fungal contaminants is a major limiting factor in the storage stability of a number of fresh fruits and vegetables. Rot caused by fungi may develop within a few hours, as in the case of strawberries kept at ambient temperatures, or after several weeks in the case of cold-stored mangoes. Even with the application of chemicals (where this is permitted) the fungal infections may be so deep-seated that they cannot be reached effectively. One of the potential advantages of gamma irradiation is its ability to penetrate food tissues thereby making a therapeutic treatment of the infected host possible.

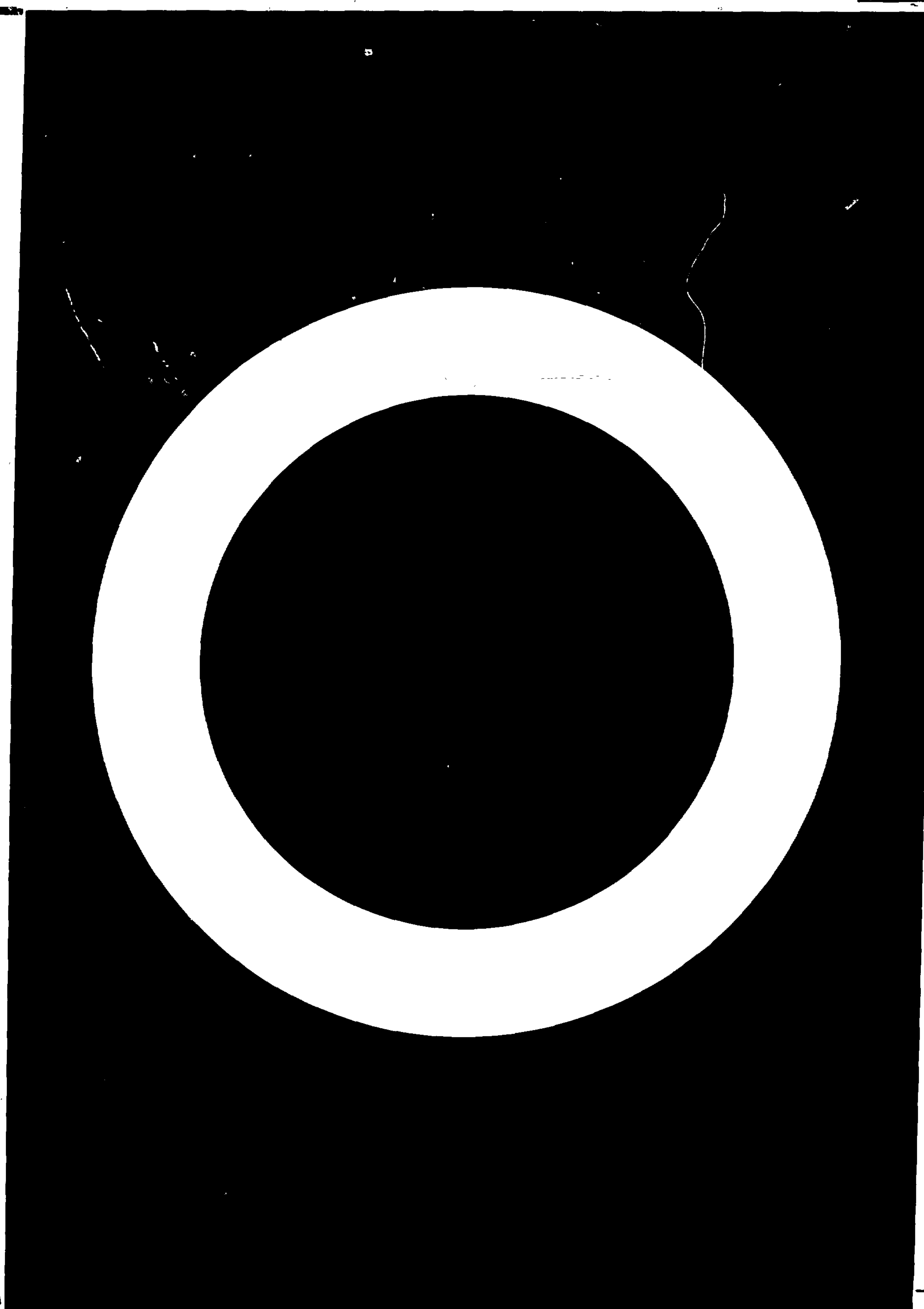
The problem which frequently arises is that there is only a very small difference in the radiation sensitivity between the food (host) and the micro-organism (pathogen). Therefore doses required to kill the micro-organism may also damage the host tissue and adversely affect taste, texture and colour of the food. Considerable interest has been shown in recent years in the enhancement of radiation lethality through combination treatments of various agents such as heating, UV radiation etc.

This paper is concerned with synergistic effects obtained with irradiation and heat treatments, especially in relation to the pathogens (fungal contaminants) and their hosts (fruits and vegetables).

Effective inhibition of the growth and sporulation of several mango fungi isolates namely *Hendersonia creberrima* and *Colletotrichum gloesporioides* was obtained in culture using combination treatments. This was confirmed in a number of experiments with mango fruits where excellent disease control was obtained with the combination of heat (55 °C for 5 min) and irradiation (0,75 kGy). However, extending the interval between heat treatment and irradiation (from one to three days) resulted in a considerable reduction in effectiveness. Possibly this time lag in the treatment, enabled the fungal DNA repair mechanism to become functional, thereby nullifying the intended synergistic effect.

Investigations with different cultivars of papayas and strawberries also clearly demonstrated the synergistic effect on disease control obtained when combining heat and irradiation treatments.

The study on synergism in food irradiation is far from complete. Investigations must be continued in order to find the optimal treatment combination for spoilage control in various biological systems, with the possible view to utilizing these combinations in commercial applications.



RADAPPERTIZATION OF MEATS

by
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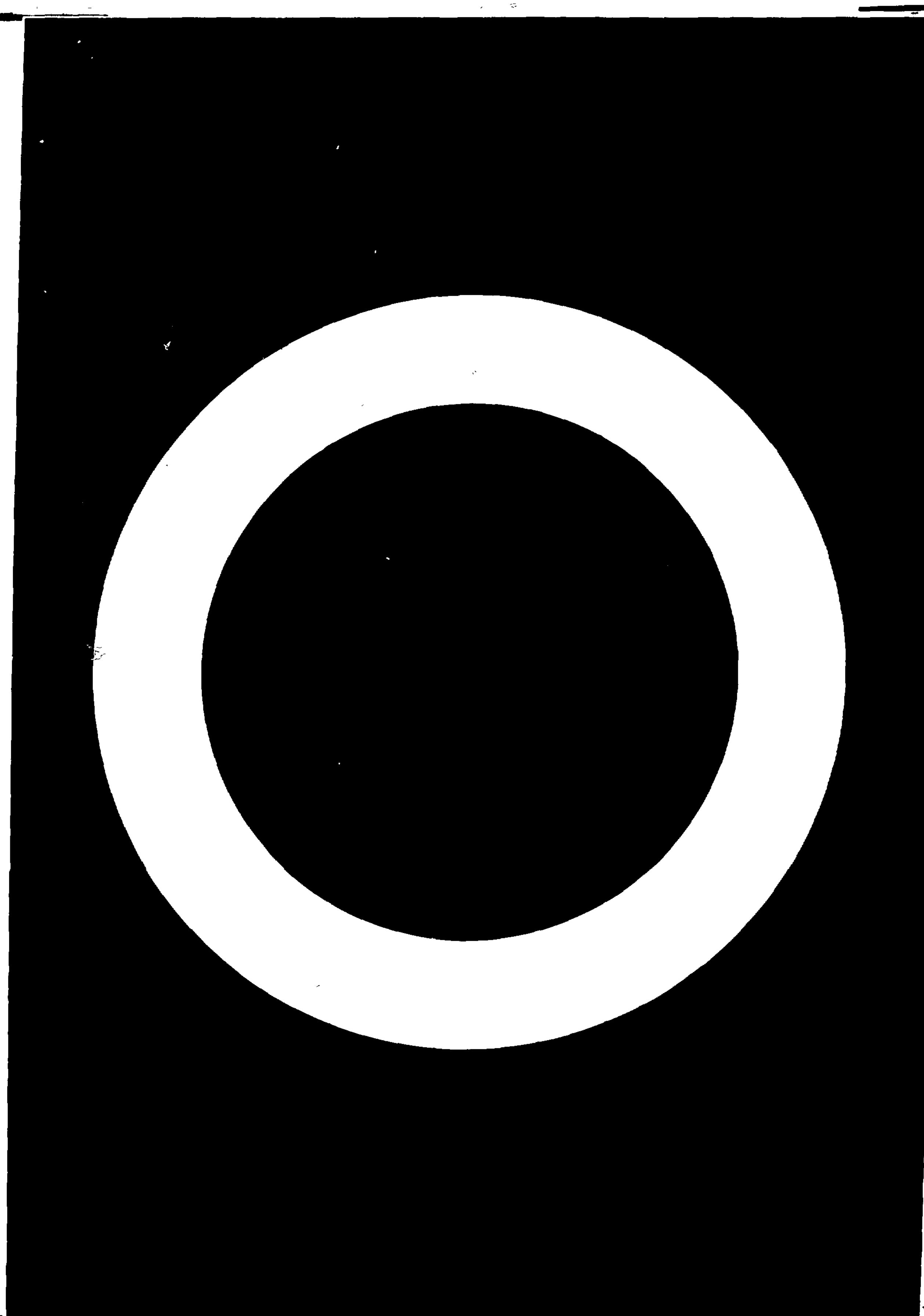
Radappertized meats of very high quality can be produced. The astronauts have had several of these items in space. The items can be stored and distributed without refrigeration. The technology will be described.



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THE STATUS OF FISH AND POULTRY IRRADIATION IN THE WORLD

by
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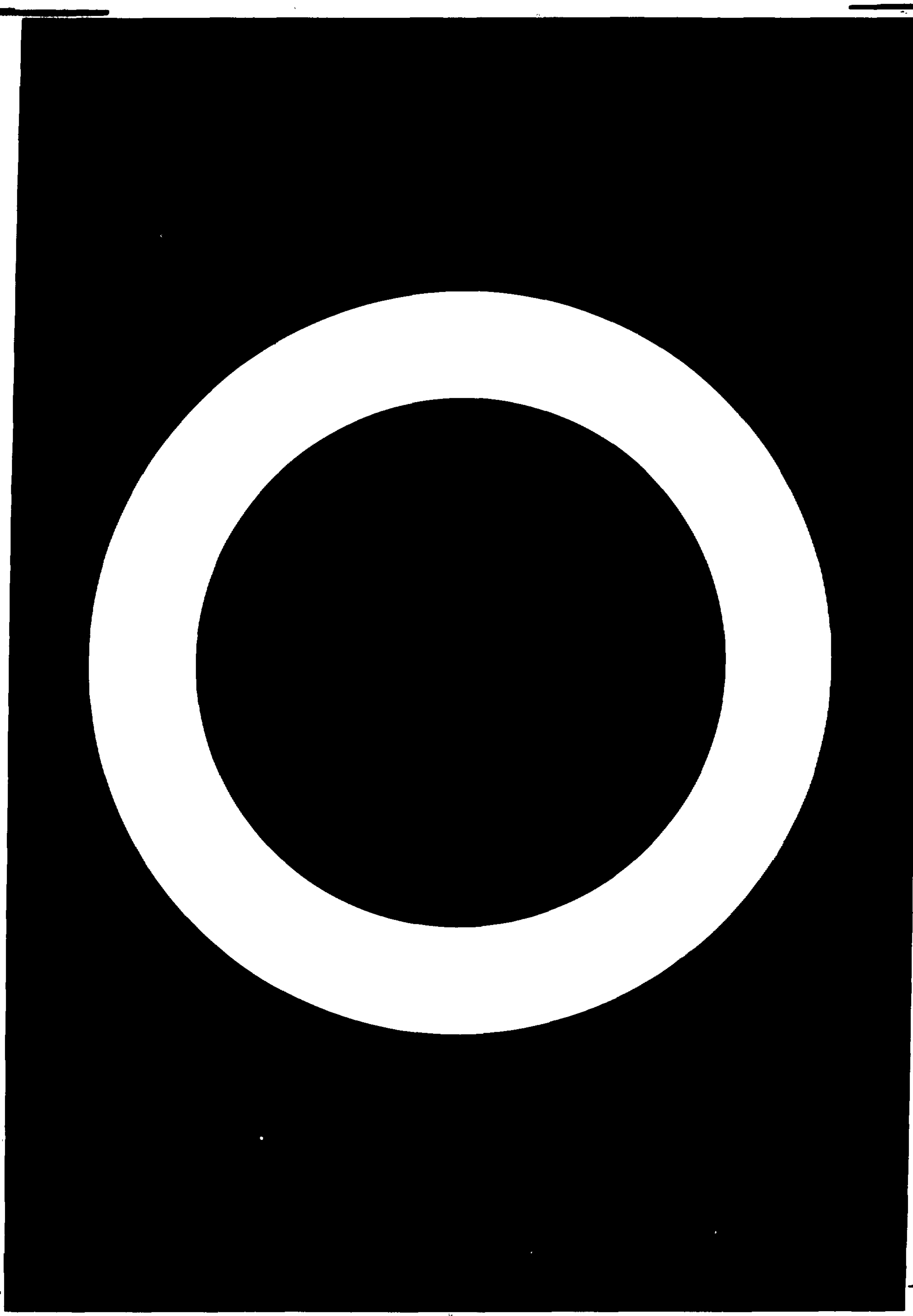
Irradiation of food, and consequently, national clearances have concentrated hitherto on applications for desinfestation and sprout inhibition of various cereals, potatoes and onions. There has been less activity in relation to the clearance of irradiated poultry and fish. At present experimental batches of eviscerated poultry have been approved in the USSR and the Netherlands; irradiated chicken is approved in Canada, the Netherlands and South Africa.

With respect to fish only Canada has approved the test marketing of cod and haddock fillets, while irradiated shrimps have been cleared in the Netherlands for trial as experimental batches.

A considerable amount of testing is underway in the US to support an application for clearance by the FDA of irradiated chicken.



PROBLEMS, PRACTICES AND PROSPECTS OF THE RED MEAT INDUSTRY OF SOUTH AFRICA

by
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Animal and Dairy Science Research Institute, Irene

Red meat is the most expensive item in the food budget, comprising as much as 40 % of the monthly food expenditure of the South African consumer. It is therefore of the utmost importance that the meat industry should establish and maintain the optimal image of the product in order to satisfy a buyer becoming increasingly quality conscious. This favourable image is achieved by the efficient functioning of and synchronization between the eight links in the meat production chain. The first two, controlled by the livestock producer, are the genetic and physiological composition of the animal which has to produce the maximum meat in a given environment. The second production phase, managed by the middle man, consists of four links, i.e. the slaughter, storage, processing and marketing. The last "person" in the chain towards whom the entire effort of image building is aimed, is the consumer. Buyers' satisfaction is the ultimate object of a successful meat industry. The key to the latter is a quality guarantee at the most reasonable price possible. In the case of complete functional harmony between the eight links in the meat industry, optimal quality can be guaranteed to the customer. However, because of diversification in industry and diverging interests and loyalties of entrepreneurs, much has yet to be done in South Africa to establish this sought-after optimal image of red meat. Three of the most important aspects of such a goal are maximum shelf life, as well as processing and eating qualities of the product in all its forms. Each of the eight links in the production chain has a real bearing on these meat characteristics. In view of the theme of this conference attention will be focussed mainly on those aspects related to the shelf life of red meat.

1. It is essential that slaughter stock, their carcasses and the saleable meat should be as free as possible of pathogenic organisms. For this purpose the necessary legislation has been drawn up.

2. However, virtually no legislation or guideline standards are available to ensure or promote shelf life as the prime object, especially in the fresh meat industry, which is certainly to the detriment of as perishable a foodstuff as fresh meat. It is therefore the moral duty of the production managers, responsible for the first seven links in the chain, as well as of the consumer, to ensure optimal keeping quality of the product.

3. Problems related to shelf life of meat which have already been identified in South Africa and which are receiving attention through research, development and extension, are the following:

3.1 The main sources of pig and beef carcass contamination by spoilage organisms have been investigated at abattoirs. The different activities of the slaughter procedure have varying effects on organism load of carcasses. The final chilling process is particularly effective in reducing total surface counts. In the pig slaughter-line the hot water immersion and dehairing process has been found to be an important source of contamination, however, singeing almost sterilizes the carcass surface. The deboning process, as well as the various stages in product manufacture, cause an increase in total bacterial counts. When heat or smoking is applied during processing appreciably lower counts are achieved in the saleable product. In a further investigation at butcher shops, very high bacterial counts have been found in minced meat as well as beef and pork sausages.

3.2 Preslaughter and slaughter stress of livestock have a very detrimental effect on meat quality. The rate and extent of lactic acid formation in muscle are of the utmost importance in establishing optimal shelf life of meat. It affects the water-binding capacity as well as the growth and survival rate of spoilage organisms. Drip in fresh, chilled or thawed meat is an ideal source of nutrition for micro-organisms which affect appearance, colour stability, protein denaturation and therefore also the shelf life of meat. One kind of stress adversely affecting meat quality is that which occurs when livestock are in transit for long periods and which is accentuated when groups of animals strange to each other are mixed under unfamiliar circumstances. Muscle glycogen is uitilized for energy production when muscles are in a stressed condition. When animals with a low glycogen reserve are slaughtered without having been given the opportunity to rest in order that these reserves may be replenished, a low lactic acid content (high pH : $> 6{,}0$) results in the meat then being dark, firm and dry (DFD). Meat of this kind is of a poor processing quality with a very limited shelf life. Unacceptably dark colour in consumers' packaged meat, as well as greening of vacuum-packed prime cuts, are two of the most typical phenomena of DFD meat.

Another kind of stress found mainly in pigs is that which occurs directly prior to or during the slaughter process. Fighting, rough handling, incorrect electrical stunning or captive bolt stunning of pigs all cause severe preslaughter stress resulting in contracted muscles after slaughter, causing an increase in the rate of *post mortem* glycolysis to such an extent that a pH of less than 6 is usually recorded while the muscle temperature is still higher than 30 °C. Protein denaturation, poor water-binding capacity and a masked pale colour cause muscle to be pale, soft and exudative (PSE) with very poor processing quality of pork.

3.3 Efficient slaughter procedures are very important in establishing optimal meat quality. Stunning animals in the *medulla oblongata* results in poor bleeding hence poor keeping quality of the product. Using unsterilized knives for severing blood vessels could also result in blood contamination and therefore also muscle and meat contamination. Undue delay of bleeding after stunning results in elevation of blood pressure causing muscle venules to rupture and the occurrence of 'blood splash' adversely affecting shelf life of meat.

3.4 One of the most paradoxical practices in the entire meat industry from a quality promoting point of view is that of rapid carcass chilling. Storage at 0 °C and lower, inhibit micro-organism growth very effectively but too rapid chilling or freezing of prerigor meat has a severely detrimental effect on the tenderness, water-binding capacity and hence on the processing and eating quality of the meat. Inefficient chilling, especially of large and fat carcasses, on the other hand, could cause 'bone taint' or the growth of anaerobic micro-organisms in the deeper parts of the carcass in which the temperature has not been lowered to less than 15 °C and especially when the pH is still higher than 6,0. Pathogenic organisms, such as certain *Salmonellae*, grow rapidly under aerobic conditions at temperatures above 7 °C. Microbiologically speaking, carcasses should therefore be chilled or frozen as soon as possible after slaughter, i.e. even after the *prerigor* stage (pH>6,0). However, the energy content of muscles at this point in time is still high enough to enable muscles to contract, and to do so severely when exposed to extreme temperatures. Rapid chilling, i.e. 10 °C within 10 h after the slaughter, causes 'cold shortening' and *prerigor* freezing results in 'thaw rigor'. Typical symptoms are extremely tough meat with poor water-binding capacity. On the other hand, a slow freezing rate results in formation of large ice crystals causing unacceptably high moisture loss on thawing and this could also lead to poor shelf life. Rapid freezing of prechilled vacuum-packed meat is a definite prerequisite for low drip loss on thawing.

'Ageing', or the process of muscle proteolysis, tenderizes meat by means of the inherent muscle enzymes when carcasses or cuts are stored in a chilled condition for periods between 5 and 21 days. Slime formation due to bacterial growth or browning due to oxidation or micro-organism damage are factors which may affect appearance and shelf life of ripened meat and could be counter-productive to quality promotion through ageing.

3.5 Meat is being wrapped with oxygen permeable film for the sale of consumers' packs in supermarkets at an ever-increasing rate. This kind of film facilitates oxymyoglobin formation causing meat to 'bloom' and attain an attractive cherry red colour. Shelf life can be severely affected by high bacterial counts under these aerobic conditions which may be further accentuated if meat is of a low acidity (pH>6,0) such as DFD meat. A poor shelf life and an unnatural dark colour are unacceptable meat characteristics for an increasingly critical consumer.

4. Meat is an expensive item in the South African housewife's food budget, hence the importance attached to shelf life and eating quality. Fortunately considerable expertise is available regarding quality preservation and improvement, irradiation being the one presently discussed.

IRRADIATION OF EDIBLE FOOD ANIMAL OFFAL

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Professor : Veterinary Food Hygiene and Public Health

Apart from muscle meat, animals slaughtered for food also provide various items of "edible offal". In Southern Africa and elsewhere where there is a traditional demand for low cost protein of animal origin, availability is economically and nutritionally of considerable significance. Composition analyses show the excellence of offal as a source of essential amino acids.

"Rough" offal requires to be cleaned to rid the epithelium of adherent ingesta and the naturally astronomically high bacterial population before it can be classed as edible. Rumenal wall is perhaps the most sought after portion of the gastro-intestinal tract (GIT) used as food. Rough washed, the average mass of a bovine paunch amounts to 8,46 kg; this is reduced to 5,28 kg by scalding and scraping. Rumenal wall offal is sold from offal pools at an average price of 30c and 77c/kg for rough washed and scraped offal respectively. Most such offal is sold in the rough washed state, i e. after immersion or tumbler washing and hung to allow water to drip off. It may be sold unchilled or chilled or frozen in blocks.

Such offal is of a highly perishable nature by virtue of catheptic and microbiological spoilage unless frozen. Consumers and retailers of offal rarely possess refrigeration facilities and shelf life is consequently rather short. Where frozen blocks of offal are supplied, the material must be allowed to thaw prior to division into retail portions unless a band saw is available.

Apart from poor keeping quality, offal has been shown to harbour micro-organisms which are potentially pathogenic or toxigenic and therefore unacceptable in other foods. Even though offal may be thoroughly cooked before consumption, the hazards associated with the handling of contaminated material and the possible contamination of other raw or precooked foods are well known.

Surveys have shown that many traditional consumers of GIT offal prefer the "natural" state to one where processing has altered organoleptic properties. Even scraping and scalding is not favoured – perhaps also because of the higher cost/kg of such offal.

In terms of the usual microbiological standards applied to meat, GIT offal can only be classed as unsatisfactory and unhygienic. Methods are therefore required to improve its microbiological state so as to render it more hygienic and extend its keeping quality without materially adding to the cost to the consumer and without significantly altering the "natural" appearance of the product. Radurisation appears to present an obvious method of processing such rough offal in order to achieve these objects, at least at the larger abattoirs in the controlled areas of the Republic where about 1,5 million cattle (± 68 % of the total) are slaughtered annually.

A series of experiments were undertaken to assess the application of γ-radiation at levels of 2,0–6,0 kGy (200–600 krad) to rough washed bovine ruminal wall.

Initial experiments involved the irradiation of fresh minced rumenal wall offal (RWO) after the usual rough washing process. Determination of the total aerobic and anaerobic mesophilic bacterial population indicated that after dosages of 100–200 krad, counts decreased by >90 %. Species of certain genera, notably *Bacillus, Micrococcus, Streptococcus, Staphylococcus* and *Clostridium* survived up to 600 krad of γ-radiation. Contamination of minced RWO with 24 h old cultures of *S. aureus, S. dublin* and *C. perfringens* was effected and the organisms could not be recovered after 600 krad. This work was done with material kept at about 4 °C and it appeared that the keeping quality of RWO could be extended by a factor of 2–3 by radurisation.

Subsequent studies were undertaken to find an objective method of assessing the degree of spoilage without resorting to establishment of microbiological counts. Fresh RWO has a characteristic unpleasant odour to the non-consumer and great variation exists between organoleptic evaluation norms of traditional consumers. The H_2S content, pH and Total Volatile Nitrogen (TVN) levels of fresh, untreated and irradiated RWO (whole and minced) was determined after storage at 4 °C and at room (ambient) temperature (RT). None of these parameters provided outstanding measures of the condition of the material but in almost all instances the irradiated material (200, 400, 600 krad) fared better than untreated controls. The advantage of irradiation was generally more marked in material stored at RT than at 4 °C. Initial pH and TVN valued for RWO were higher than those of red meat. Good correlation between these parameters, the bacterial counts and organoleptic changes of RWO could not be established.

Considerable variation in the initial bacterial counts complicated assessment of the value of irradiation. Log_{10} average counts of untreated RWO kept at RT for 24 h were usually about 2 decimals higher than when stored at 4 °C. Log_{10} counts rose to 10,9/g by Day 2 at RT but only achieved such levels on Day 25 when stored at 4 °C. In general, irradiation led to significant decimal reduction of both aerobic and anaerobic counts. There was evidence of self-limitation of total bacterial counts at Log_{10} 10–11, regardless of treatment or storage temperature.

Heating of RWO to 80 °C prior to irradiation with 400 krad gave better results than irradiation alone, even up to 600 krad. This aspect demonstrates the necessity of thermal inactivation of catheptic enzymes apart from destruction of microbial agents by radiation. A limited organoleptic evaluation of the acceptability of untreated and irradiated RWO stored for various periods at RT and 4 °C failed to yield conclusive results regarding favourable extension of shelf life by irradiation.

It is concluded that although irradiation of offal holds certain promise, further work is required. The economics of the process have not yet been investigated.

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THE EFFECT OF GAMMA RADIATION ON THE LARVAL STAGES OF TAPEWORMS

by
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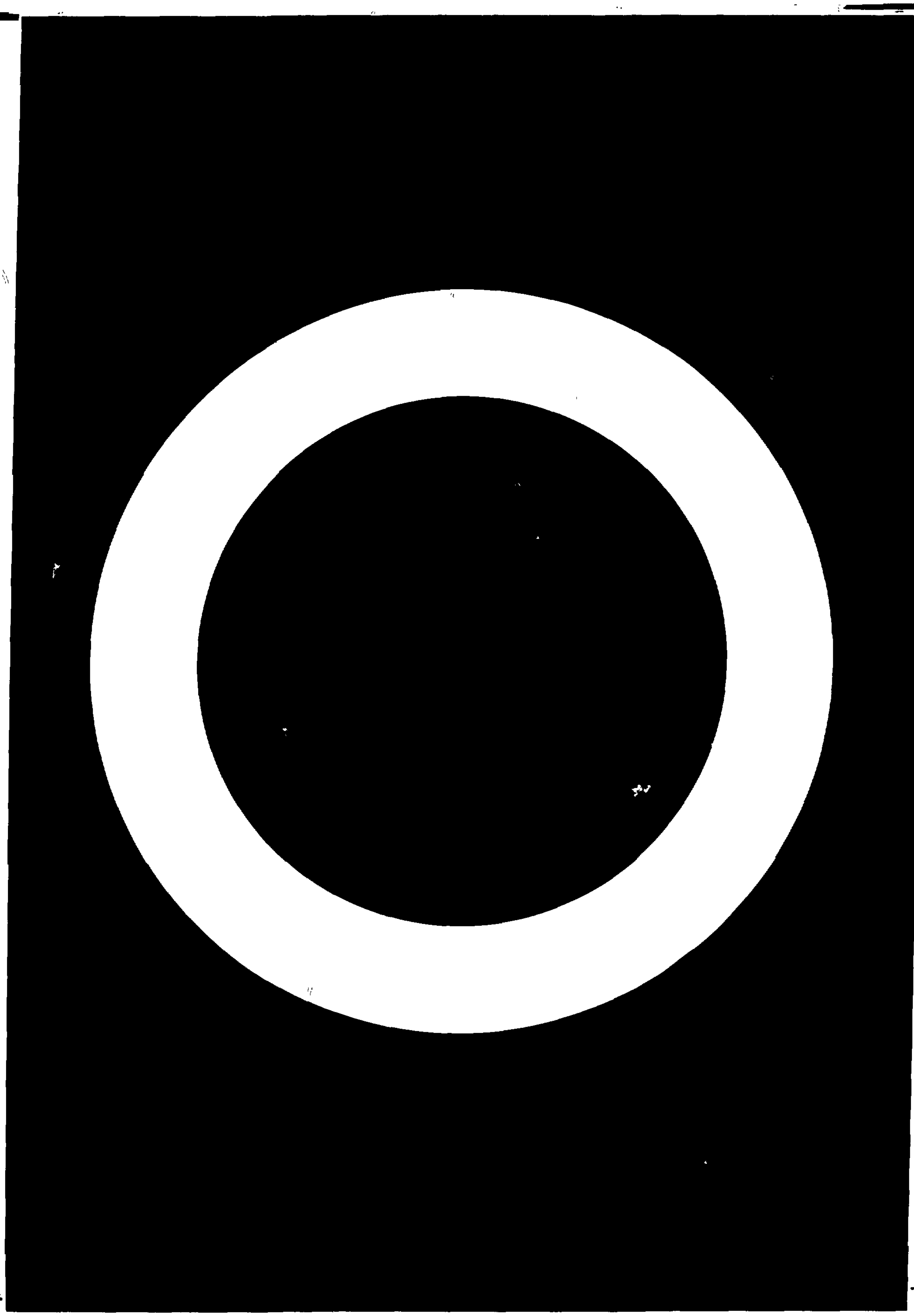
Cysticerci of *Taenia solium* and of *Taenia saginata* were exposed to gamma radiation in doses varying from 0,2 – 1,4 kGy. Radiation had an adverse effect on the ability of the cysticerci to evaginate *in vitro* after a time lag of 9 days in *T. solium* and after 6 days in *T. saginata*. Some cysticerci of *T. solium* treated with low doses (0,2 – 0,8 kGy) evaginated 24 days after treatment but no *T. saginata* cysticerci evaginated after 15 days.

Cysticerci exposed to radiation doses of 0,2 – 1,2 kGy are as infective to golden hamsters as untreated cysticerci. Cestodes resulting from irradiated cysticerci, however, cannot maintain themselves indefinitely and are excreted or digested from Day +12 onwards. Such tapeworms do not grow but are resorbed and finally consist of only a scolex. It appears that radiation inhibits the ability of the cells to divide and the cells do not recover from this treatment.

Carcasses lightly infested with cysticercosis could be rendered fit for human consumption by exposure to low doses (0,2 – 0,6 kGy) of gamma radiation.



PROBLEMS IN THE BROILER POULTRY INDUSTRY

by
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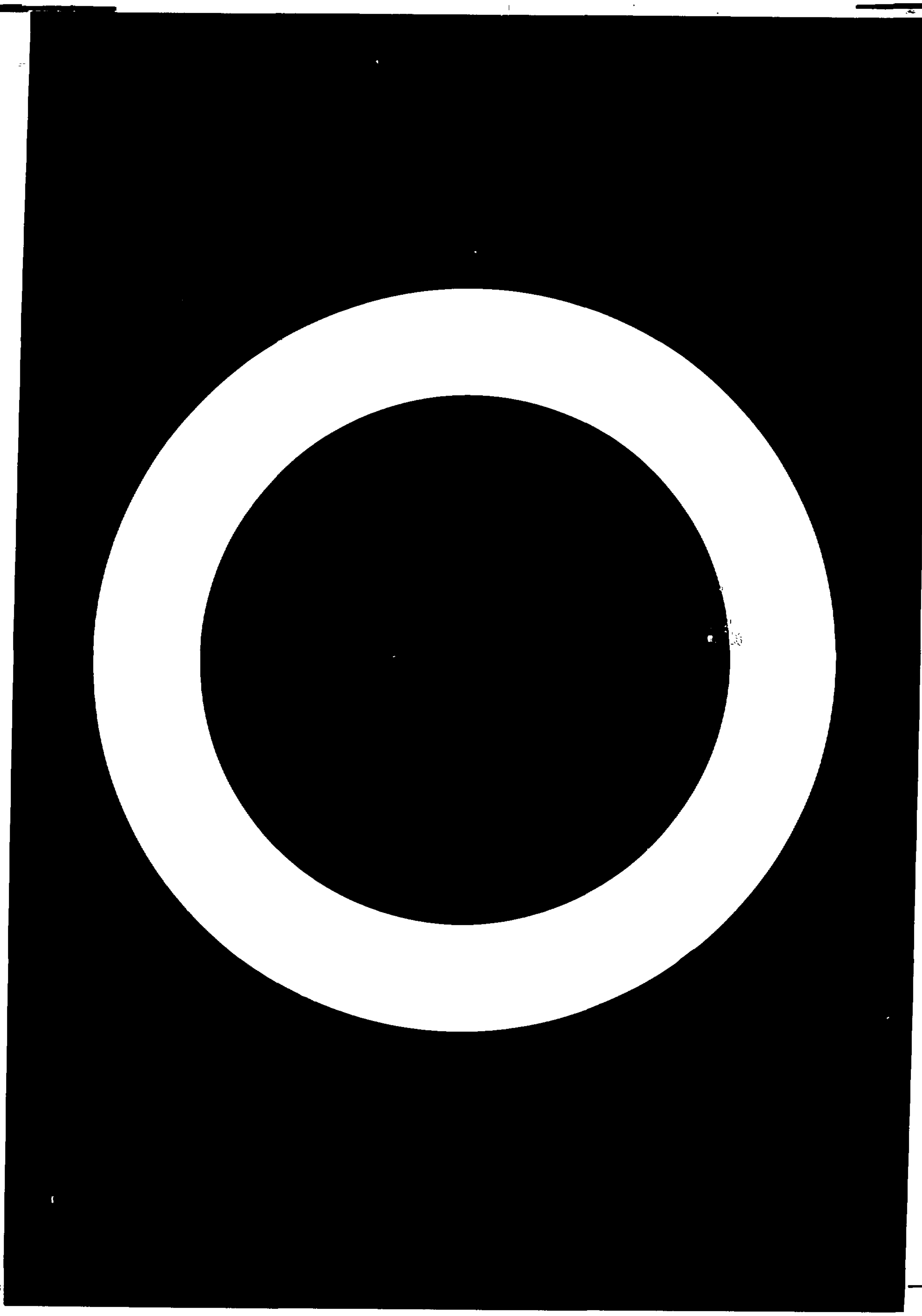
Farm Fare (Pty) Ltd

Changing buying habits are causing a swing away from frozen poultry, with an indefinite shelf life, towards fresh poultry with a limited shelf life. Demand for fresh poultry varies with the day of the week, week of the month and month and season of the year. This creates the problem of anticipating demand and having the poultry available for distribution while still maintaining a steady and efficient production system. Production systems require a steady supply of raw materials and a steady offtake to be efficient. When demand varies, storage after production is used to take up surplus production in anticipation of future demand.

Fresh poultry, being perishable, cannot be held over for the future and production is thus varied to meet demand. Processing methods which extend shelf life by reducing microbiological contamination could assist the manufacturer to become more efficient by utilising mid-month and early-week idle capacity. Delivery scheduling could be rationalised and considerable fuel and labour savings achieved.

Modern concern over more hygienic food and potentially harmful food additives gives weight to methods which will ensure pathogen-free foods with no added chemical preservatives.



FRUIT PRODUCTION IN SOUTH AFRICA

by
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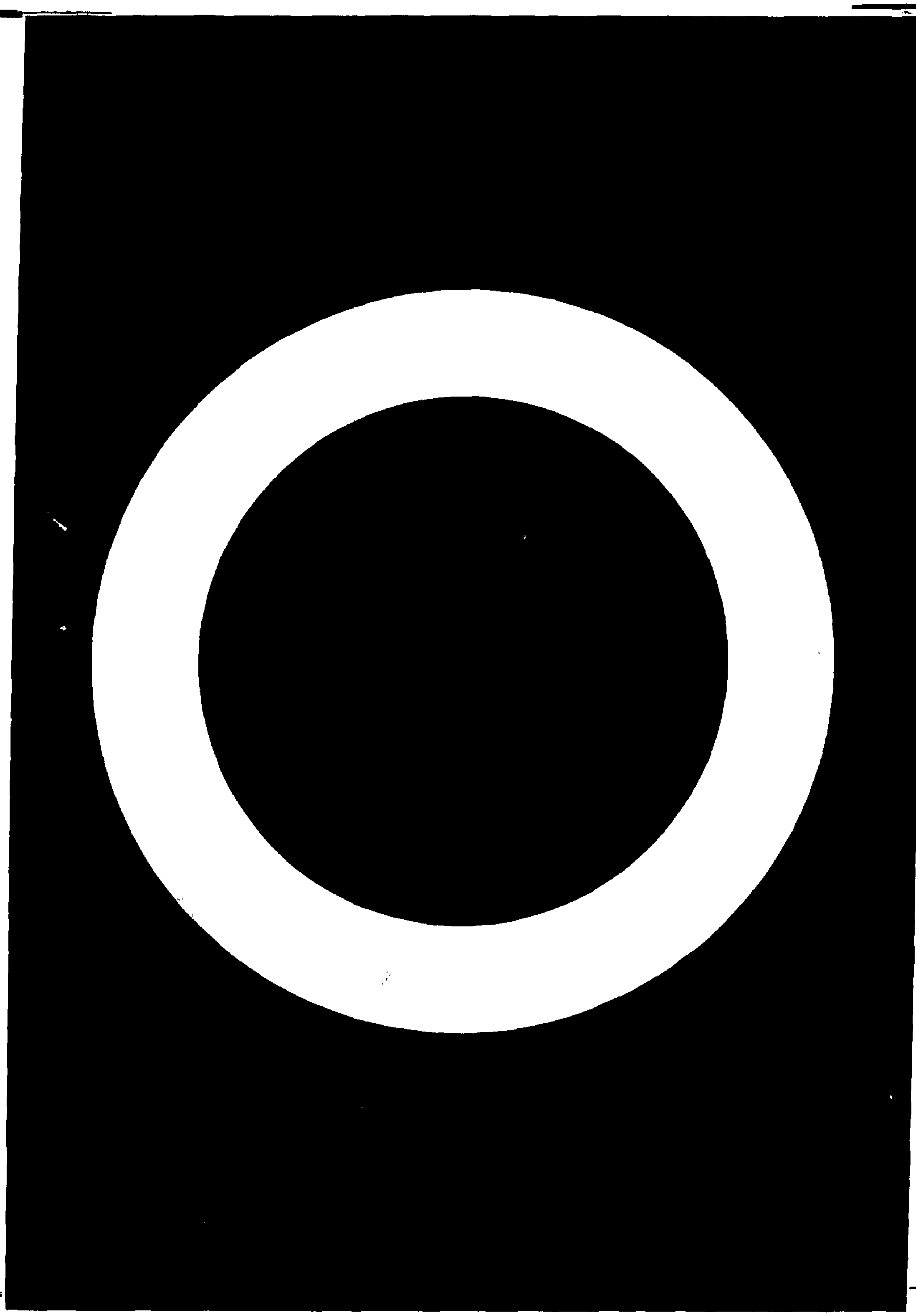
The areas in South Africa where fruit is produced are discussed with reference to the climatic zones that occur in the country. South Africa is very fortunate in that most climatic types which favour fruit production, except real tropical conditions, occur. This fact makes it possible to successfully produce a great variety of fruits.

The production of the most important fruit type, such as deciduous fruits, grapes, citrus and subtropical fruits are discussed and statistics on production, marketing and growth of the industries are also given.



VEGETABLE AND POTATO PRODUCTION IN SOUTH AFRICA

by
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Department of Agricultural Technical Services, Pretoria

VEGETABLES

With a gross value of R126 million per year, vegetable production contributes about 3,3 % to the total gross value of agricultural production in South Africa. Tomatoes, onions, pumpkins and squashes, cabbage, green peas, carrots and green beans are the most important vegetables grown.

Vegetables are grown throughout the country with almost no evidence of concentrated, demarcated production areas. Exceptions are the somewhat concentrated tomato production in the subtropical areas of Eastern and Northern Transvaal; onions in the Caledon, Ceres and Venterstad districts of the Cape; green peas in the Marble Hall area of Central Transvaal and in the Outeniqua area of Southern Cape. The greater part of the total vegetable crop is being produced as secondary or side-line ventures to other main branches of agriculture.

About 1,4 million tons of vegetables were produced in 1978. The increase in tonnage amounts to an average of 3,9 % per year over the last 10 years which is about one third higher than the population growth of the country. The vegetable crop is being grown on an estimated 65 000 ha of irrigated land which is fairly static since the growth in total tonnage is being achieved by a gradual improvement in operational efficiency.

The wide diversity of climatical subregions in the country, including subtropical areas, results in a stable supply of vegetables on the local markets, throughout the year, obviating the need to import vegetables or to store over prolonged periods. For the same reason protected cultivation of vegetables in plastic structures or greenhouses finds it very hard to compete with open ground production.

Vegetable production in South Africa is aimed almost exclusively at supplying the local market. Only about 40 000 tons of vegetables are exported annually which represents 2,8 % of the total crop. Exports do increase steadily but the scope for expansion is still extremely favourable and entirely unexploited.

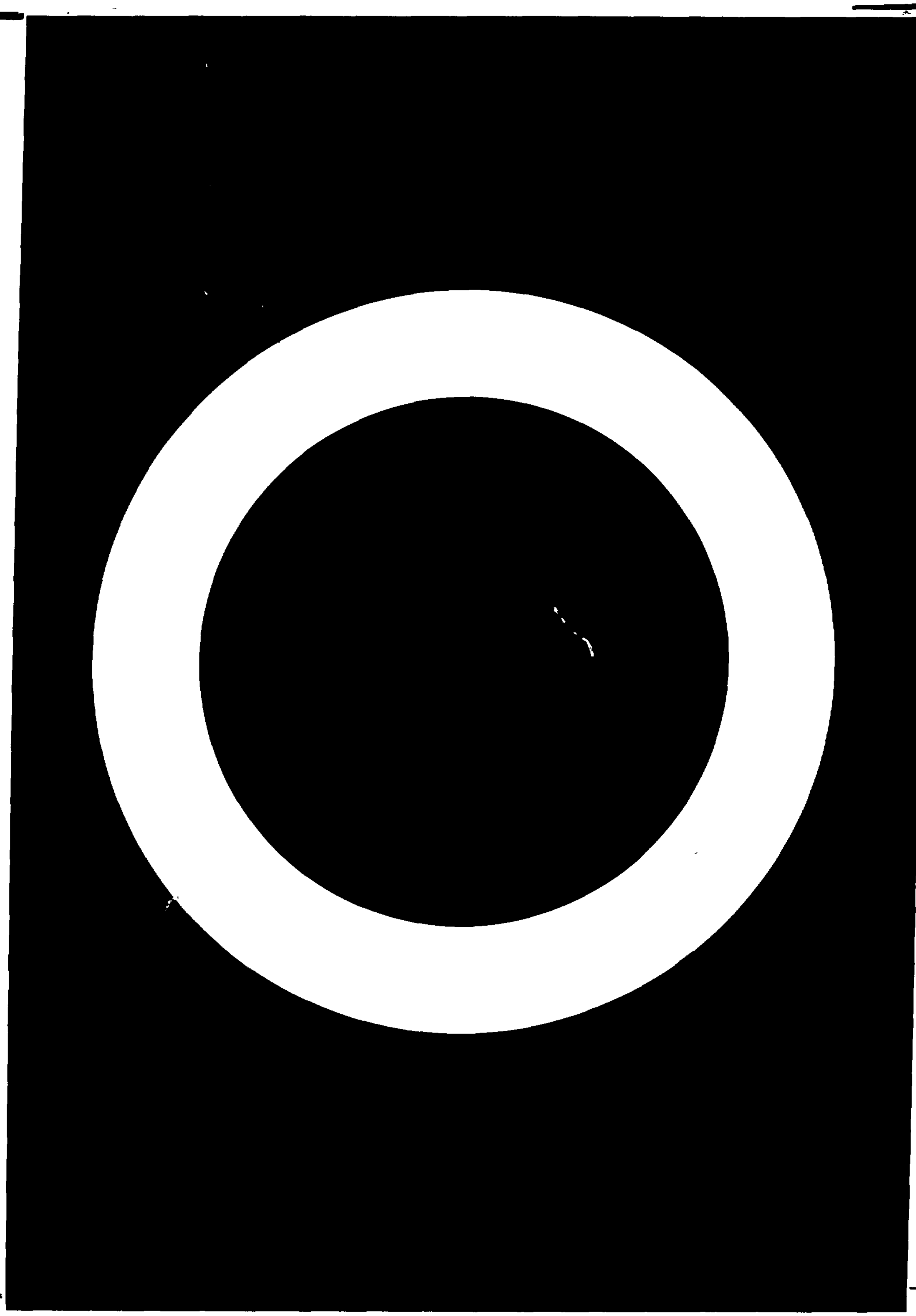
Ten percent of the vegetables produced are being processed with emphasis on green peas, green beans, tomatoes and brassicas. It is expected that dehydration will grow much faster than canning and freezing, although up to now it has lagged behind.

Onions, garlic, mushrooms and melons are considered as priorities for radiation research. Sprouting, dessication and bulb rotting disease organisms during storage over a period of up to 6 months are limiting factors in the local marketing of onions and garlic. The shelf life and maintaining of freshness in mushrooms are unsatisfactory. Existing work on these crops should be finalised, and research on melons initiated to overcome the problems of decay during sea transport to Europe.

POTATOES

The total annual potato production in South Africa is approximately 750 000 tons with a market value of between R60 and R80 million. The main production area (according to yield) is the Transvaal (38 %) followed by the Orange Free State (27 %), the Cape Province (25 %) and Natal (10 %). In contrast to most European countries, winter and summer productions are possible in all the provinces except the Orange Free State. Despite fluctuations in supply there is a continuous supply of fresh potatoes throughout the year to all the important consumer areas.

In South Africa only seed potatoes are stored for any length of time. Table potatoes and those used in the processing industry reach their destination within about two to three weeks from harvesting with a maximum period of up to five weeks. One of the serious drawbacks in the potato industry is the poor keeping quality (shelf life) of the potato under local conditions. Rotting, greening and sprouting are the most important causes. Control of these by irradiation has already shown promising results. The potential use of irradiation in the potato industry can therefore be seen as very good.



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QUANTITATIVE AND QUALITATIVE ASPECTS OF AGRICULTURAL PRODUCTS

by
P J WESSELS
Director:
Inspection Services Department of Agricultural Economics and Marketing

1.0 INTRODUCTION
The main functions of the Division of Inspection Services and its role in the marketing of agricultural products.

2.0 THE SHELF LIFE OF AGRICULTURAL PRODUCTS
Short review of present methods with a practical example of losses incurred due to limited keeping quality.

3.0 IRRADIATION AND HEAT TREATMENT
Advantages of inhibited microbiological activities and undesirable chemical changes from a quality control point of view.

4.0 QUALITY STANDARDS
The basic principles of quality control.

5.0 CONSEQUENCES OF EFFECTIVE POST-HARVEST TREATMENT

5.1 Export

5.1.1 Deciduous and citrus fruit
The magnitude of the problem of poor keeping quality and quality requirements.

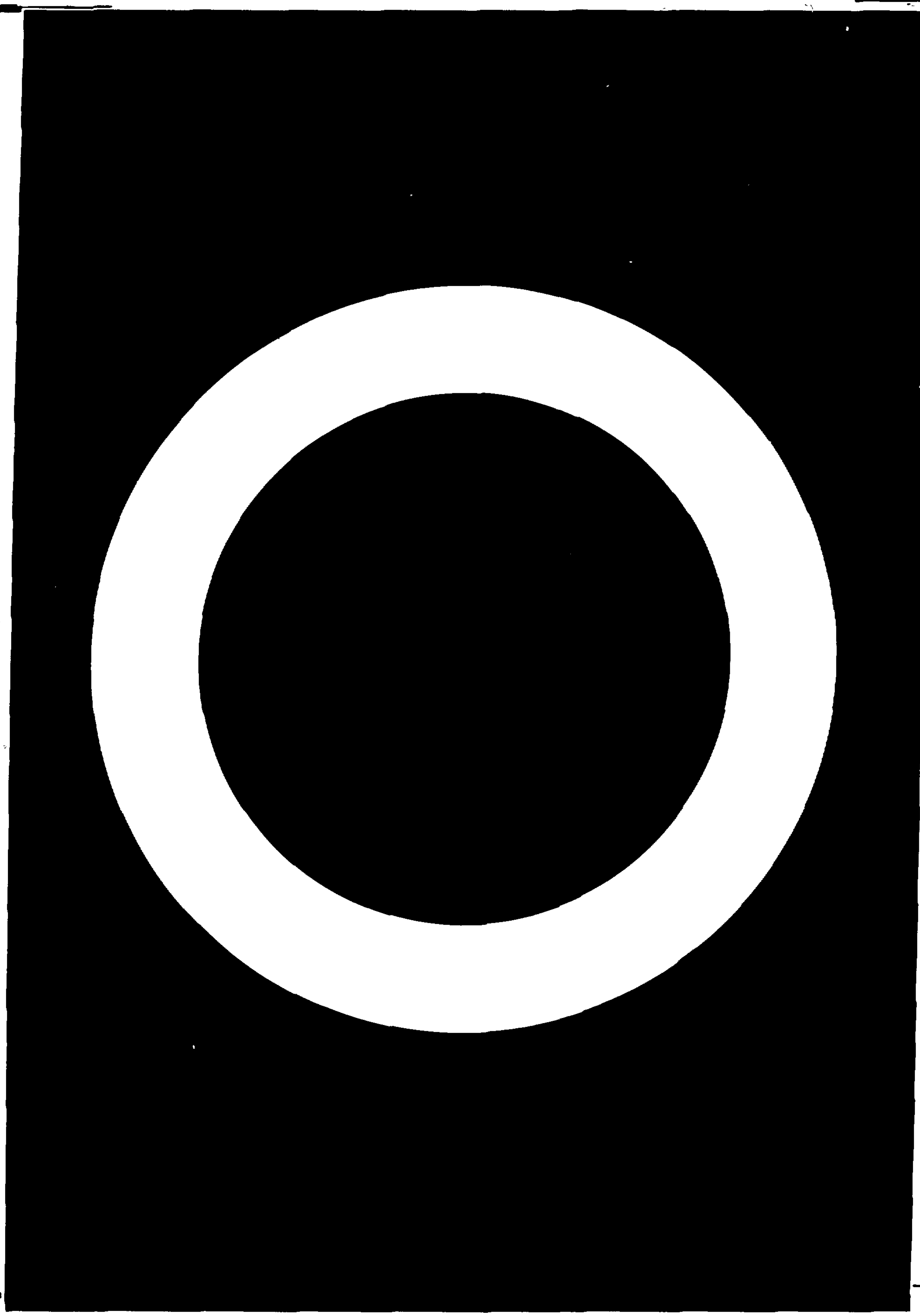
5.1.2 Other fruit
Quantities and export limitations.

5.1.3 Vegetables – Exports
Quantities and quality requirements

6.0 LOCAL MARKETING
Fruit and vegetables subjected to inspection
Quantities and quality aspects.

7.0 CONCLUSIONS
(a) The type of defects which cause quality control problems.
(b) The consequences of improved keeping quality and the general advantages involved.
(c) Legislation concerning irradiated agricultural products.
(d) Advantages offered by irradiation.
(e) The Division of Inspection Services' role in the irradiation project.

8.0 Annexures indicating greater qualitative and quantitative detail.



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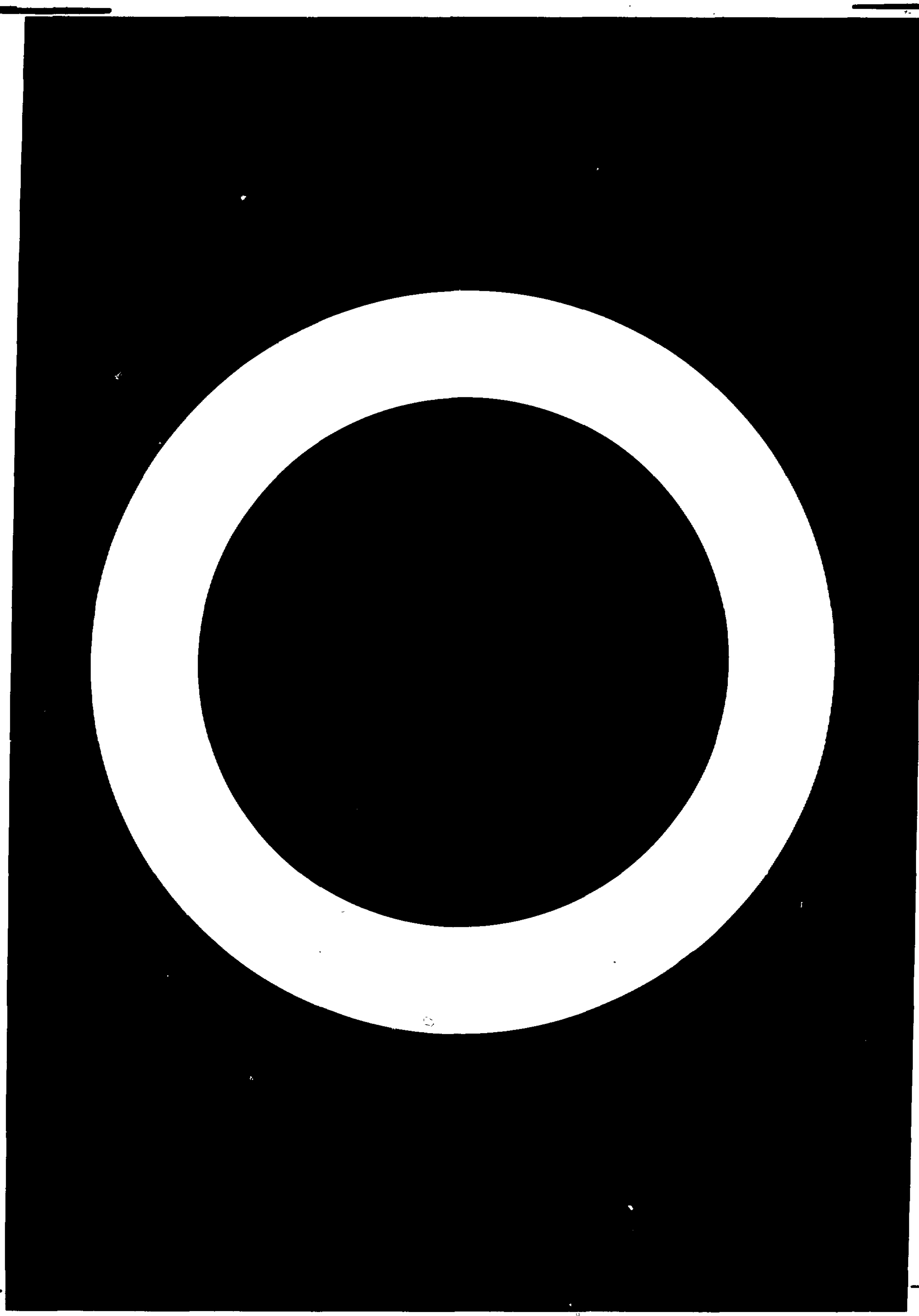
SOUTH AFRICA AS AN INTERNATIONAL SUPPLIER OF AGRICULTURAL PRODUCTS

by
O J la GRANGE
Director: Export Trade Promotion
Department of Commerce and Consumer Affairs

Despite limited resources and a generally unfavourable climate, South Africa's agricultural industry is expanding more rapidly than the population. Food items which are produced in sufficient quantities to allow for export are sugar, maize, oilseeds, decidious, citrus and subtropical fruit. Canned produce are sold to more than seventy countries throughout the world.

Export of agricultural products will, as in the past, have to surmount increasing barriers. Although South Africa is geographically far removed from the European market, it is well placed in terms of its production season. Overseas marketing opportunities cannot be fully exploited because of the perishable nature of the products intended for export and as a result of the high cost of air transport. A longer shelf life for perishables will enable exporters to ship them by sea. The benefits which food irradiation technology could bring to South Africa's export trade are obvious.



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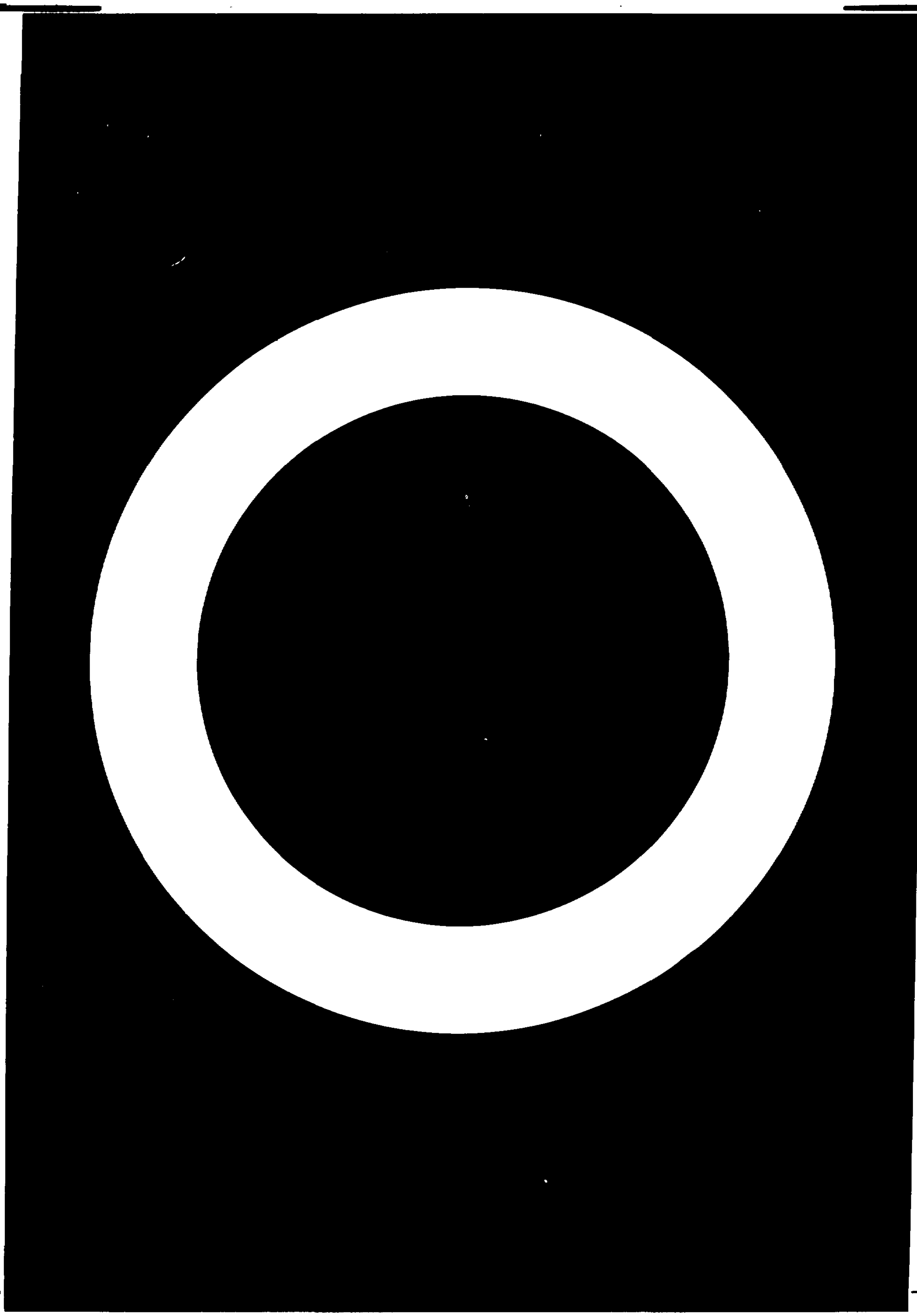
REGULATORY ASPECTS OF IRRADIATED FOOD

by
P N SWANEPOEL
Deputy Director, Environmental Health Services,
Department of Health, Pretoria

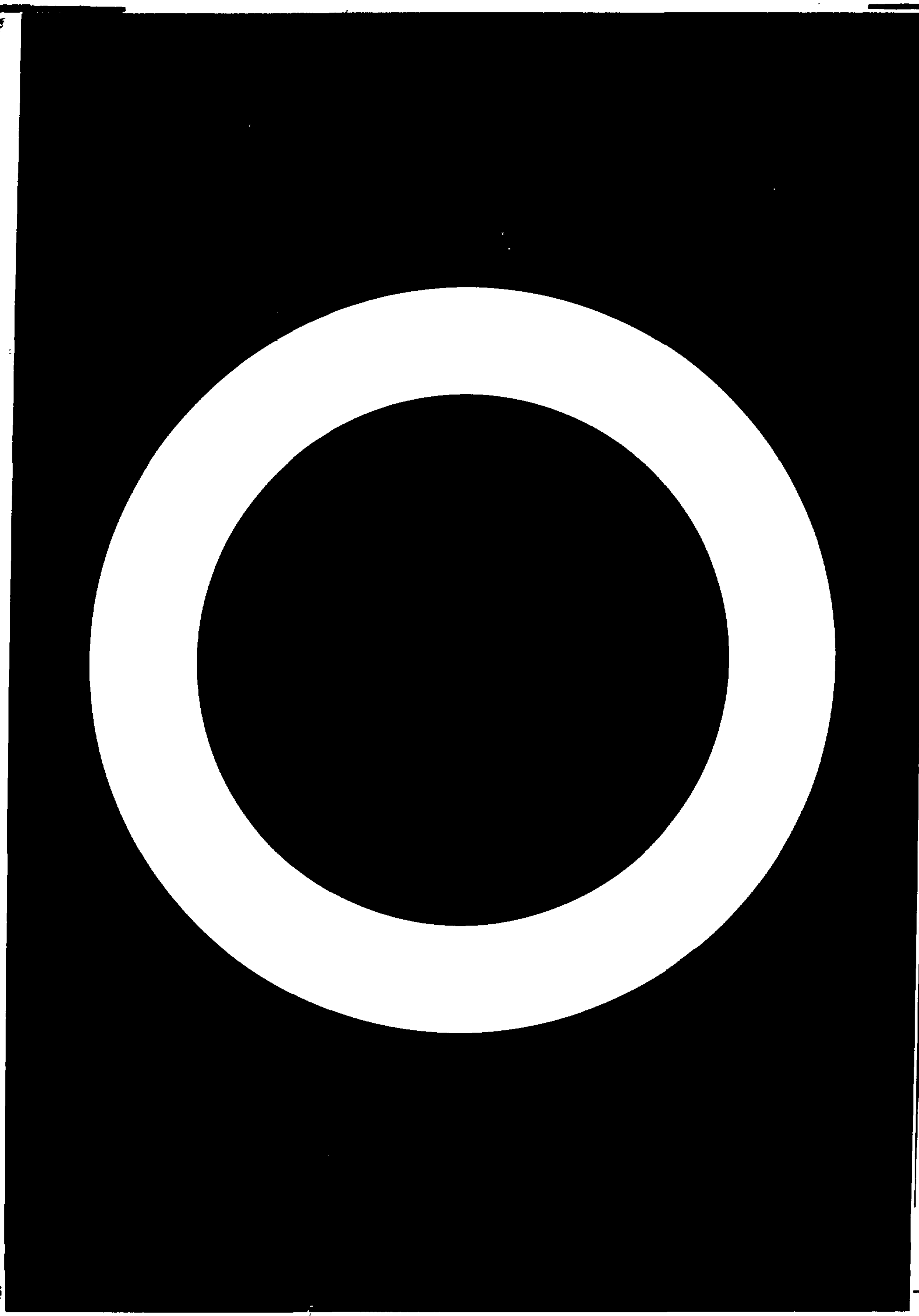
A short review is given of the legislation administered by the Department of Health which regulates the processing, manufacture and sale of foodstuffs; the prohibition of the sale of irradiated food unless such sale is permitted by the Minister of Health; the conditions which he may stipulate for the sale of irradiated food; the philosophy for the classification of irradiation as a food process and not a food additive; the protocol required by the Department of Health when authorisation for the sale of irradiated food is requested; the conditions under which toxicological and other data which have been submitted to other regulating authorities for the sale of the same or a similar foodstuff will be accepted in the Republic of South Africa; the labelling and advertising of such approved irradiated food; the desirability of uniform legislation between neighbouring states so as to facilitate trade in irradiated food between those states and finally international legislation to facilitate international trade.



ORGANISATION OF MARKET TESTING OF IRRADIATED FOODS IN SOUTH AFRICA

by
H J van der Linde and H T Brodrick
Atomic Energy Board

In order to commercialise the process of food irradiation it is necessary to implement an overall strategy. In this presentation a basic outline of the strategy for the marketing of irradiated food in South Africa is given and the organisation of market testing for both local and export markets discussed.



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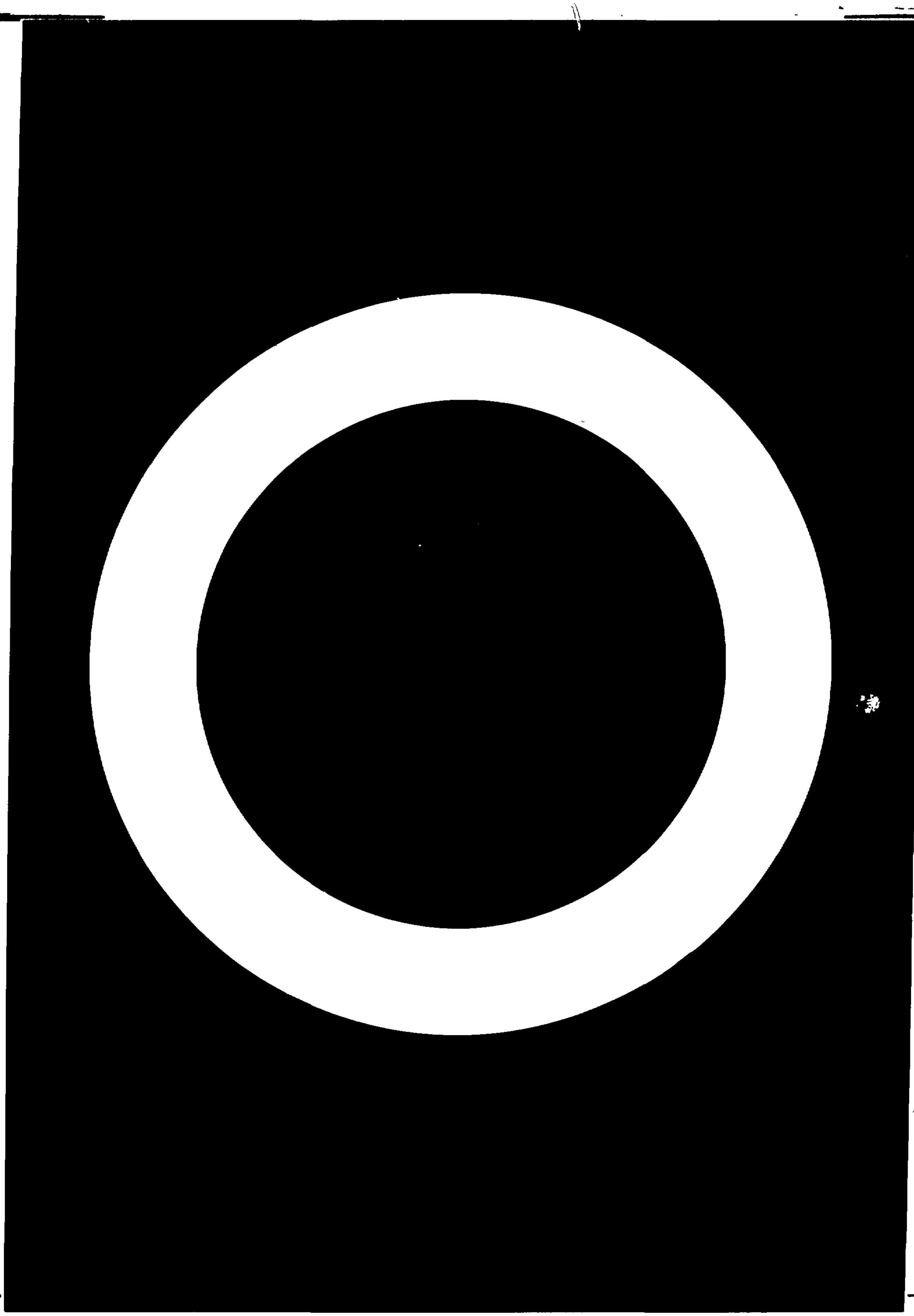
MARKET TESTING OF IRRADIATED FOOD IN SOUTH AFRICA

by
H T BRODRICK AND H J VAN DER LINDE
Atomic Energy Board

A large-scale marketing trial was launched during August 1978 within a few days following the granting of clearances by the Minister of Health for several irradiated products in South Africa. It was decided to irradiate and market four food items, i.e. potatoes, strawberries, papayas and mangoes as these were in season at that time. The trial was first started in four stores and eventually extended to 20 supermarkets in the Pretoria-Johannesburg area over an 8 month period. The effectiveness of the radiation treatment in reducing disease in strawberries and mangoes as well as over-ripening in papayas and greening in potatoes, was clearly reflected in the high positive response (88–95 %) on the part of consumers who replied to questionnaires in these trials.

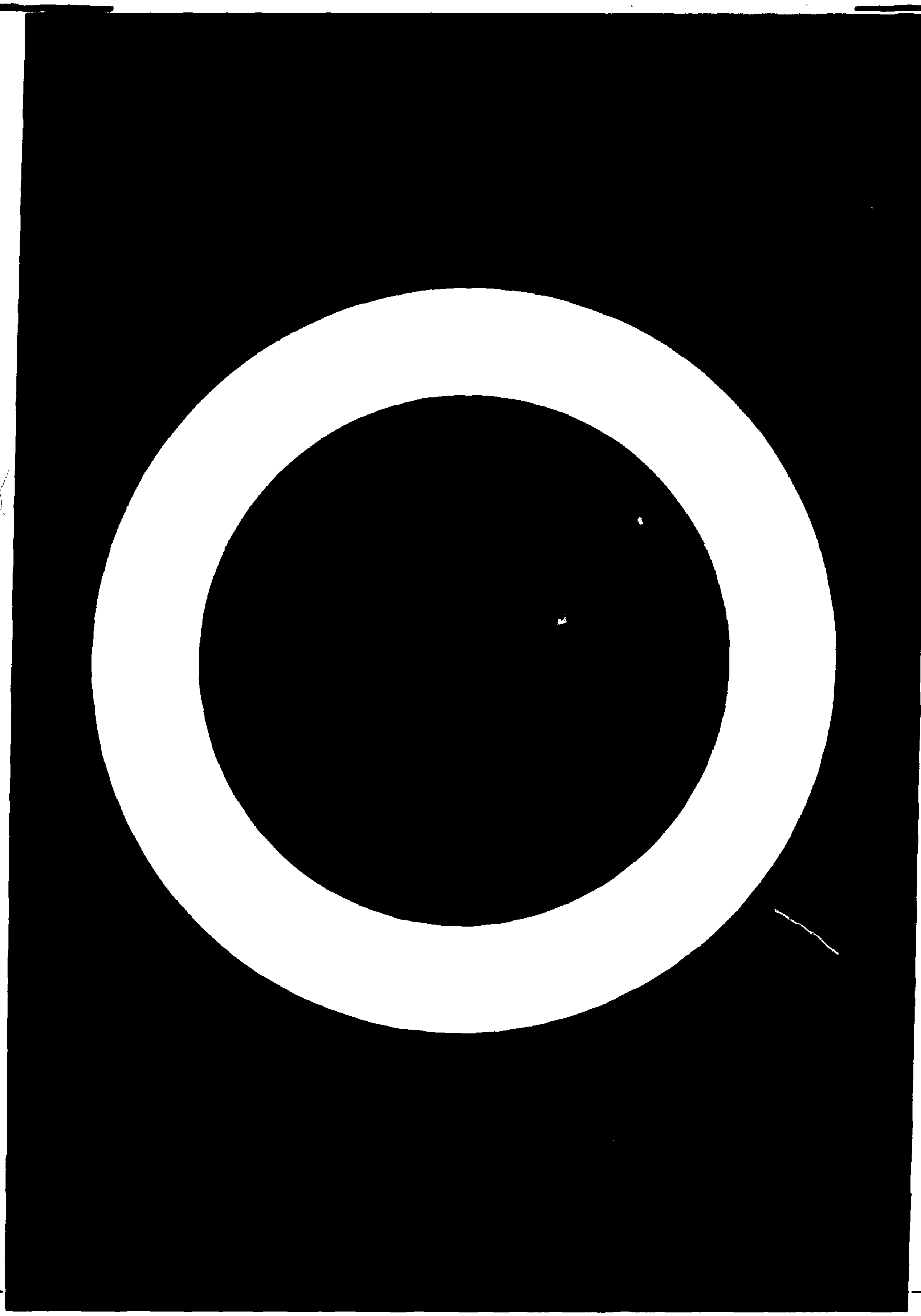
However, several problems were also encountered during the course of these trials, some of which are discussed in this paper. These include indifferent attitudes of retail staff, poor handling, inadequate storage facilities and the supply of inferior quality food by the primary supplier or prepacker. Emphasis is also placed on the need for a well-formulated marketing campaign including the dissemination of relevant information before and during the trial as well as a follow-up program aimed at the education of the consumer, retailer and industrialist alike as to the benefits and limitations of the irradiation process. Clearly, unless this is successfully carried out, the next step, commercialisation cannot be considered.



RETAILER RESPONSE TO FOOD IRRADIATION

MR N WEBB
(OK BAZAARS, JOHANNESBURG)

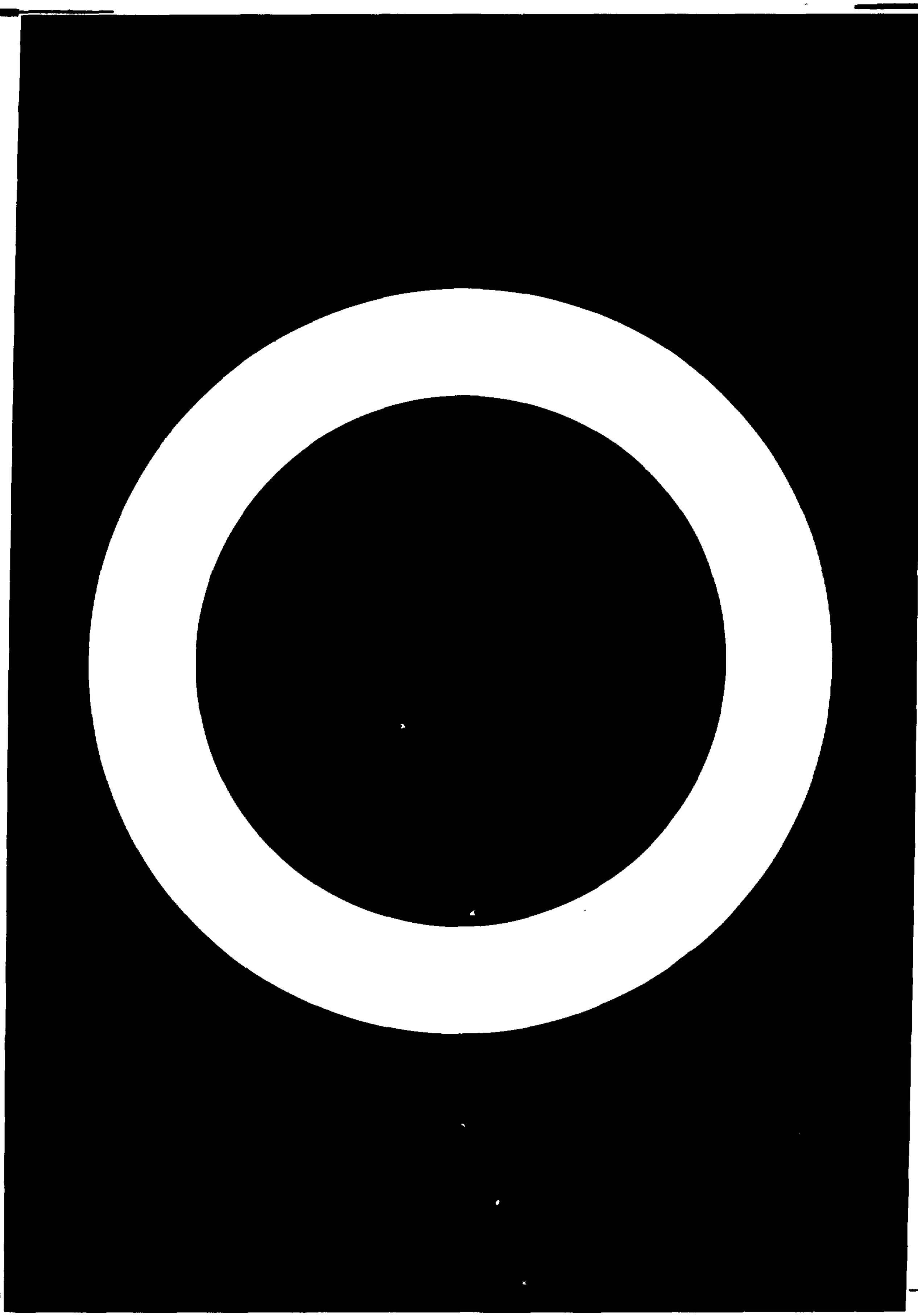
(Abstract not received)



ENERGY REQUIREMENTS AND COSTS OF RADIATION PROCESSING

by
ARI BRYNJOLFSSON
Chief, Radiation Preservation of Food Division,
Food Engineering Laboratory, US Army Natick Research and
Development Command, Natick, MA 01760, USA

The energy used in irradiation processing is negligible. The energy savings in storage and distribution of radappertized meats as compared with frozen items, are significant. The cost of the processing is about the same as conventional processing. Several examples of energy savings and irradiation costs will be given.



THE TECHNO-ECONOMIC ASPECTS OF GAMMA RADIATION PROCESSING

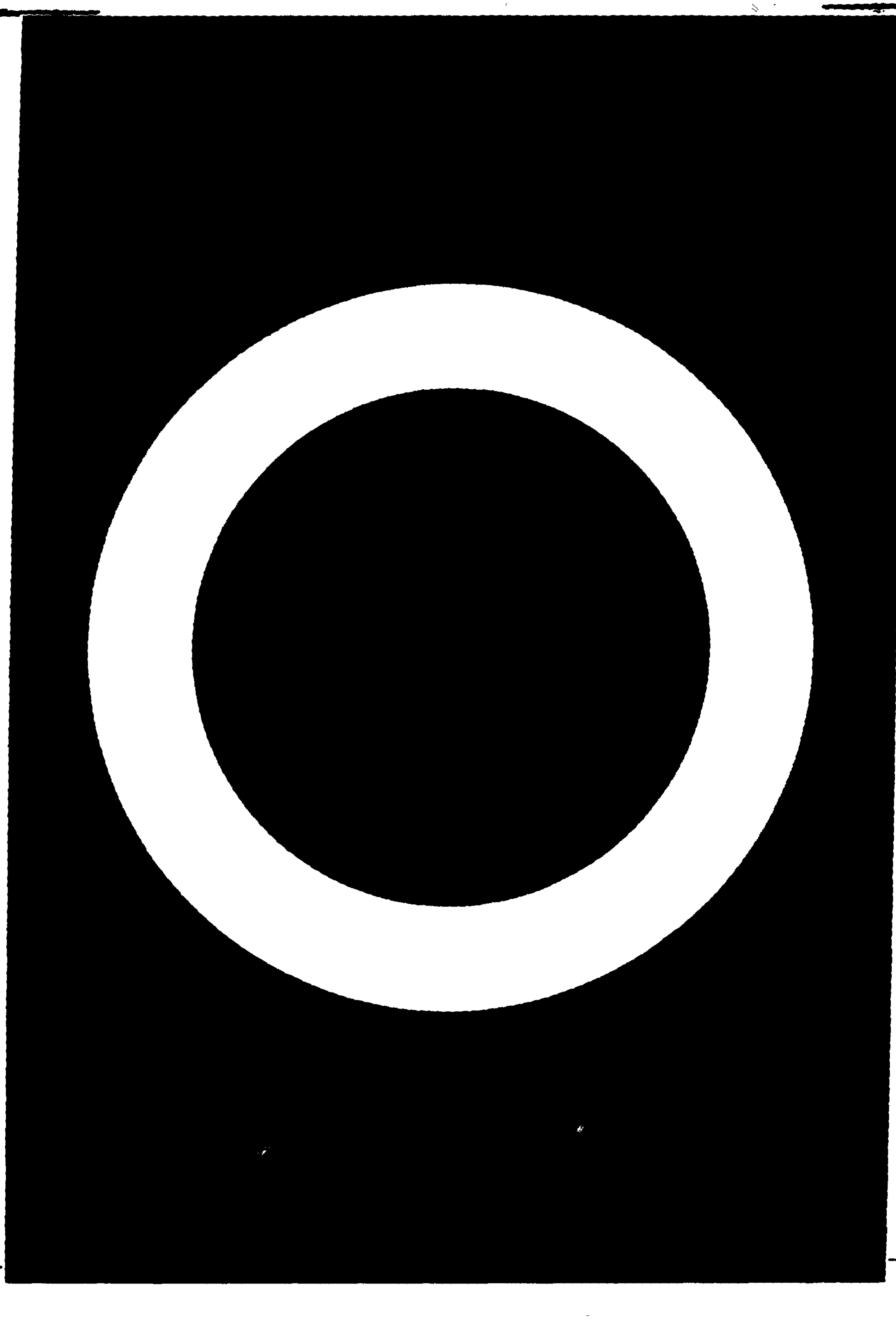
by
T A DU PLESSIS
Radiation Technology,
Chemistry Division, Atomic Energy Board

The growth of commercial radiation processing over the past few years is examined and the prominent role which gamma irradiators play in this respect is discussed. The development and present status of gamma radiation processing on an industrial scale in South Africa is also briefly discussed.

The many variables affecting the design and running of a commercial gamma irradiator are briefly discussed. Special attention is paid to the influence of product density, irradiation dose requirements, dose uniformity ratio and product throughput on the techno-economic structure of such a process. The specific requirements of a particular radiation process impose certain limitations on the flexibility in gamma irradiator design and consequently multipurpose irradiators are the exception in industry today.

To illustrate the influence of these process variables on the economics of gamma radiation processing, the cost structure of an open-pool facility and a commercially available irradiator are contrasted. Although an open-pool irradiation facility requires a modest initial capital investment, the problems associated with product handling, quality assurance because of the batch nature of the process, poor energy utilisation and excessive labour requirements, as opposed to the commercial irradiator, make it an unattractive proposition except in certain specific circumstances.

A number of guidelines are presented to assist people in evaluating the possibility of introducing gamma radiation processing as a technique.



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THE OPERATION OF A PILOT PLANT POOL FACILITY

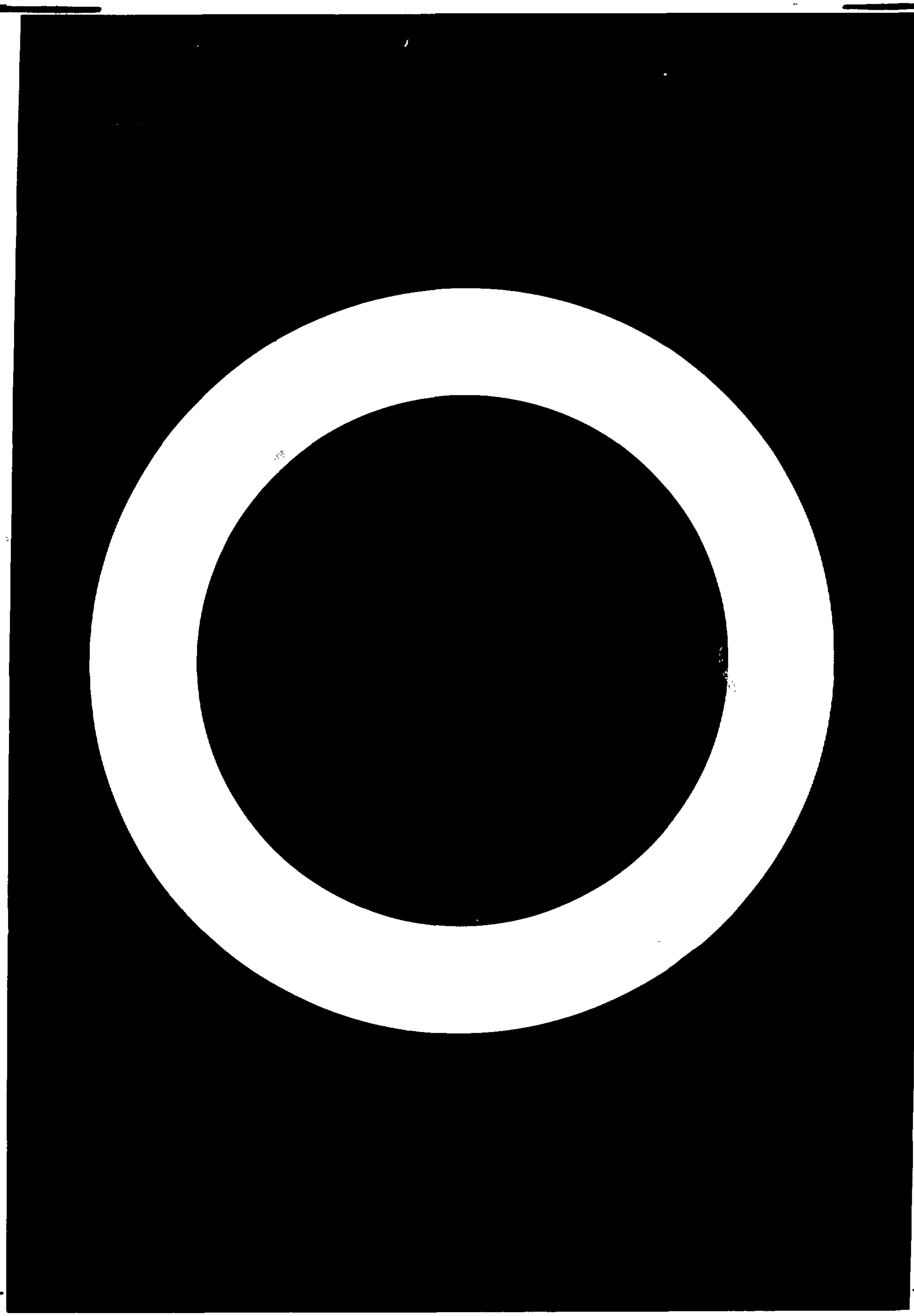
by
R LUNT
Letaba Cooperative Limited, Tzaneen

The results of research conducted at Pelindaba and at the Citrus and Subtropical Fruit Research Institute at Nelspruit have previously indicated that from a technological point of view it should be possible to undertake the commercial irradiation of subtropical fruits including mangoes, paw-paws and possibly avocados and litchis. With this in mind a large-scale open pool gamma irradiator was opened at Tzaneen in February 1977.

The basic objective of this pilot plant facility was to determine practical factors involved in the future commercialisation of irradiated products. Important points warranting further consideration were:

1. The correct siting of the facility. As the data indicate that the best results with subtropical fruits are obtained when there is a minimum delay between harvesting, hot water dipping and irradiation it seems clear that a commercial irradiator may have to be sited in the production area. Other economic considerations such as transportation in relation to centralised depots and packhouses will also be discussed.
2. The effectiveness of the pool-type irradiator for certain specific applications for various commodities and the economic benefits derived from this. The implication which these results hold for practical feasibility will also be considered in this paper.
3. The various problems which might arise in the operation, maintenance and monitoring of such a plant will also be discussed. Special attention will be given to the practical problems experienced with dosimetry for the batch operation, e.g. the setting of limits for the operator, which will meet with the requirements both from the regulatory point of view and as far as a practical effectivity is concerned.
4. Organisational aspects involved with the incorporation of irradiation into the standard post-harvest operation for various products from harvest up to the point of sale will also be discussed.
5. To test the consumer reaction to the Radura products.

The purpose of this paper is to present certain guidelines and to highlight specific problems relating to the operation of an open pool facility, gained from experience over a three-year period.



CLEARANCE OF IRRADIATED FOOD ITEMS IN SOUTH AFRICA

COMMODITY	CLEARANCE	DOSE	PURPOSE	DATE GRANTED
Potatoes	Unconditional	0,12 – 0,24 kGy	To inhibit sprouting and reduce greening during storage and marketing	Jan 77
Mangoes	Unconditional	0,5 – 1,5 kGy	To control mango weevil, diseases and delay ripening, thereby improving the keeping quality	Aug 78
Papayas	Unconditional	0,5 – 1,5 kGy	To control diseases and delay ripening, thereby improving the keeping quality.	Aug 78
Chicken	Unconditional	2,0 – 7,0 kGy	To prolong the storage life and eliminate pathogenic micro-organisms	Aug 78
Onions	Unconditional	0,05 – 0,15 kGy	To inhibit sprouting during storage and marketing	Aug 78
Garlic	Unconditional	0,10 – 0,20 kGy	To inhibit sprouting during storage and marketing	Aug 78
Strawberries	Unconditional	1,0 – 4,0 kGy	To prolong the storage and shelf life by partial elimination of spoilage organisms	Aug 78
Avocados	Provisional	max. 0,10 kGy	To delay ripening under local market conditions	July 77
Dried bananas	Provisional	max. 0,50 kGy	To control insect infestations in the packaged product	July 77

VRYSTELLINGS VAN BESTRAALDE VOEDSELPRODUKTE IN SUID-AFRIKA

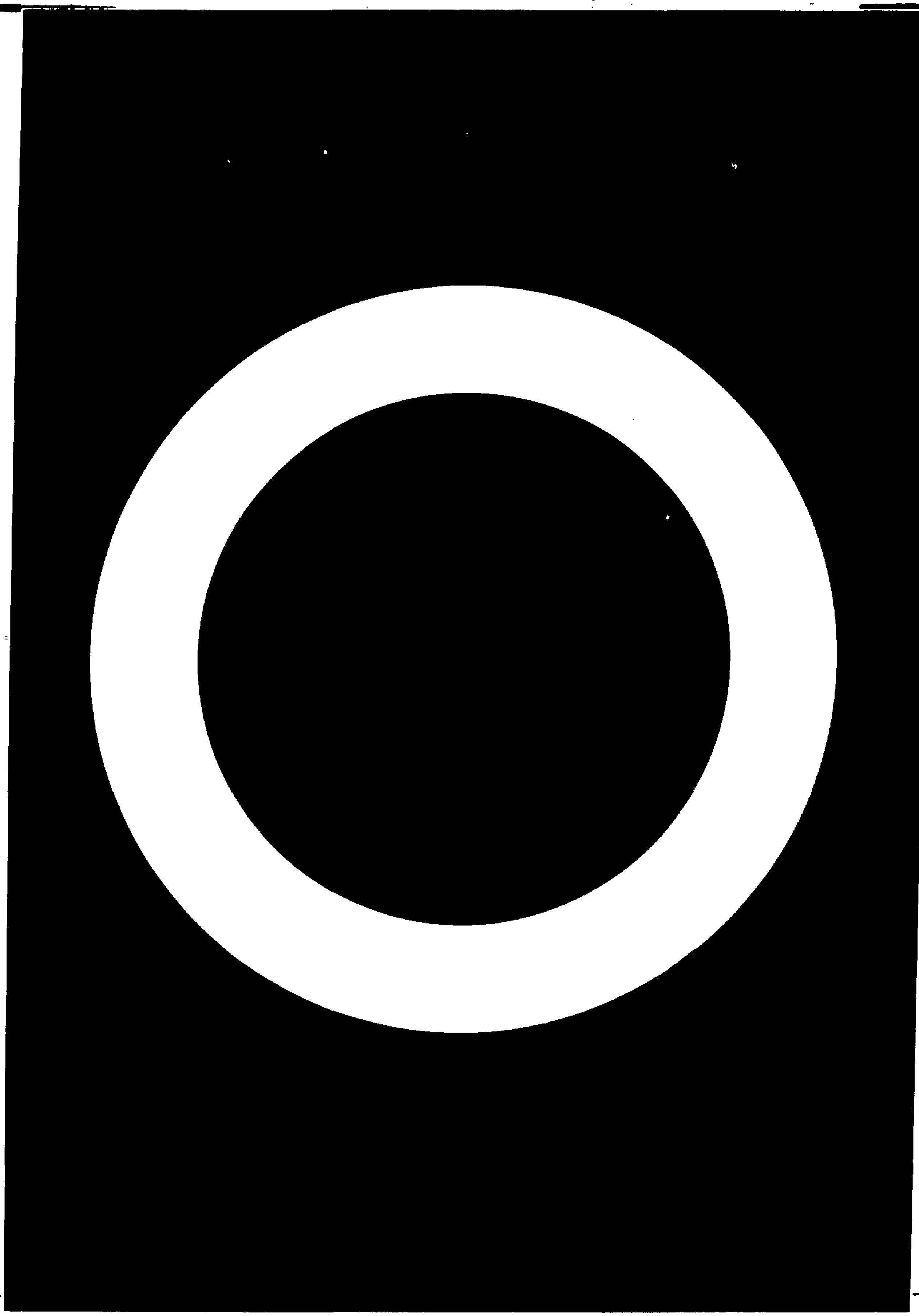
PRODUK	VRYSTELLINGS	DOSIS	DOEL	DATUM TOEGESTAAN
Aartappels	Onvoorwaardelik	0,12 – 0,24 kGy	Om uitloop gedurende op berging en bemarking te beperk en groenwording te verminder.	Jan 77
Mango's	Onvoorwaardelik	0,5 – 1,5 kGy	Om die mangokewer en siektes te bestry en ryp-wording te vertraag om sodoende die houvermoë te verbeter.	Aug 78
Papajas	Onvoorwaardelik	0,5 – 1,5 kGy	Om siektes te bestry en rypwording te vertraag om sodoende die houvermoë te verbeter.	Aug 78
Hoenders	Onvoorwaardelik	2,0 – 7,0 kGy	Om opbergingstyd te ver-leng en patogeniese mikro-organismes uit te skakel.	Aug 78
Uie	Onvoorwaardelik	0,05 – 0,15 kGy	Om uitloop gedurende op-berging en bemarking te beperk.	Aug 78
Knoffel	Onvoorwaardelik	0,10 – 0,20 kGy	Om uitloop gedurende op-berging en bemarking te beperk.	Aug 78
Aarbeie	Onvoorwaardelik	1,0 – 4,0 kGy	Om die opbergings- en rakleeftyd deur die gedeel-telike uitskakeling van bederwende organismes te verleng.	Aug 78
Avokado's	Voorwaardelik	maks. 0,10 kGy	Om rypwording onder plaaslike markomstandig-hede te vertraag.	Julie 77
Gedroogde piesangs	Voorwaardelik	maks. 0,50 kGy	Om insekbesmettings in die verpakte produk te bestry.	Julie 77

LIST OF CLEARANCES

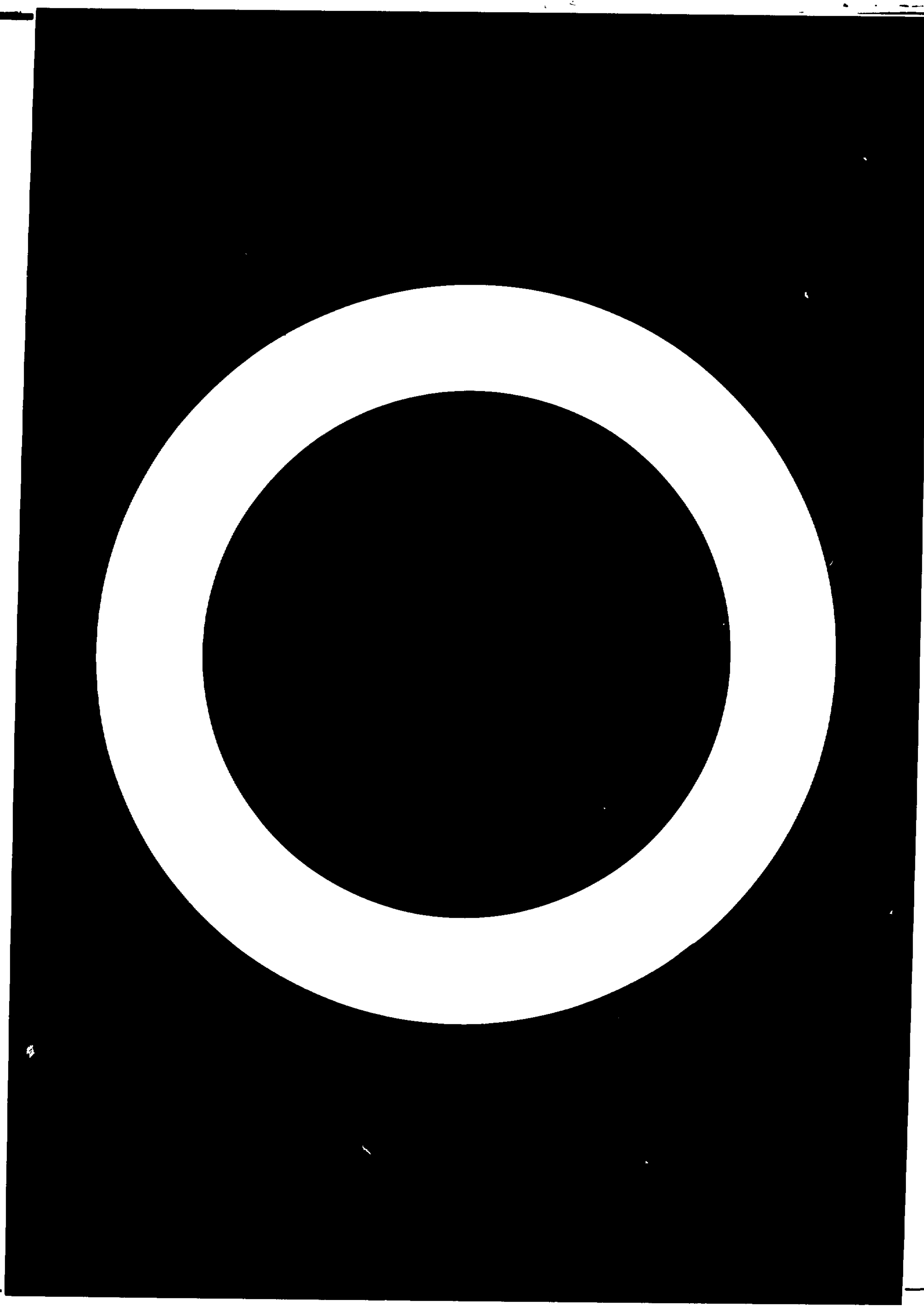
GENERAL SURVEY OF IRRADIATED FOOD PRODUCTS CLEARED FOR HUMAN CONSUMPTION IN DIFFERENT COUNTRIES

(Grouped according to country) August 1979

COUNTRY (Organisation)	PRODUCT	PURPOSE OF IRRADIATION	TYPE AND SOURCE OF RADIATION			DOSE (kGy)	DATE OF APPROVAL
			^{60}Co	^{137}Cs	electrons		
BULGARIA	potatoes*	sprout inhibition	+				1971
	potatoes*	sprout inhibition	+			0,1	30 April 1972
	onions*	sprout inhibition	+			0,1	30 April 1972
	garlic*	sprout inhibition	+			0,1	30 April 1972
	grain*	sprout inhibition	+			0,3	30 April 1972
	dry food concentrates*	insect disinfestation	+			1	30 April 1972
	dried fruits*	insect disinfestation	+			1	30 April 1972
	fresh fruits * (tomatoes, peaches, apricots, cherry, raspberry, grapes)	radurisation	+			2.5	30 April 1972
CANADA	potatoes	sprout inhibition	+			0,1 max 0,15 max	9 November 1960 14 June 1963
	onions	sprout inhibition	+			0,15 max	25 March 1965
	wheat, flour, whole wheat flour	insect disinfestation	+			0,75 max	25 February 1969
	poultry ●	radicidation (Salmonella)	+			7 max	20 June 1973
	cod & haddock fillets ●	radurisation	+			1,5 max	2 October 1973
CHILE	potatoes* ●	sprout inhibition	+				31 October 1974
CZECHOSLOVAKIA	potatoes*	sprout inhibition	+			0,1 max	26 November 1976
	onions*	sprout inhibition	+			0,08 max	26 November 1976
	mushrooms*	growth inhibition	+			2 max	26 November 1976
DENMARK	potatoes	sprout inhibition			10 MeV	0,15 max	27 February 1970
FRANCE	potatoes★	sprout inhibition	+			0,075 – 0,15	8 November 1972
	onions★	sprout inhibition	+	+		0,075 – 0 15	9 August 1977
	garlic★	sprout inhibition	+	+		0,075 – 0,15	9 August 1977
	shallot★	sprout inhibition	+	+		0,075 – 0,15	9 August 1977
FRG	deep-frozen meals*★	radappertisation	+			25 – 45	24 March 1972
	potatoes*	sprout inhibition	+			0,15 max	26 September 1974
HUNGARY	potatoes ●	sprout inhibition	+			0,1	23 December 1969
	potatoes ●	sprout inhibition	+			0,15 max	10 January 1972
	potatoes ●	sprout inhibition	+			0,15 max	5 March 1973
	onions ●	sprout inhibition	+				5 March 1973
	onions ●	sprout inhibition	+			0,06	6 August 1975
	onions*	sprout inhibition	+			0,06	6 September 1976
	strawberries ●	radurisation	+			5	5 March 1973
	mixed spices* (blackpepper, cumin, paprika, dried garlic: for use in sausages)	radicidation	+			5	2 April 1974
	mixed dry ingredients for canned hashed meats* (wheat flour, Na caseinate, onions and garlic powder, paprika)	radiation decontamination	+			5	20 November 1976
ISRAEL	potatoes	sprout inhibition	+			0,15 max	5 July 1967
	onions	sprout inhibition	+			0,1 max	25 July 1968
ITALY	potatoes	sprout inhibition	+			0,075 – 0.15	30 August 1973
	onions	sprout inhibition	+			0,075 – 0,15	30 August 1973
	garlic	sprout inhibition	+			0,075 – 0,15	30 August 1973
JAPAN	potatoes	sprout inhibition	+			0.15 max	30 August 1972
NETHERLANDS	asparagus*	radurisation	+			2 max	7 May 1969
	cocoabeans*	insect disinfestation	+		4 MeV	0,7 max	7 May 1969
	strawberries ●	radurisation	+		4 MeV	2,5 max	7 May 1969
	mushrooms	growth inhibition	+		4 MeV	2,5 max	23 October 1969
	deep-frozen meals★	radappertisation	+			25 min	27 November 1969
	potatoes	sprout inhibition	+		4 MeV	0,15 max	23 March 1970
	peeled potatoes ●	radurisation	+			0,5	12 May 1976
	shrimps*	radurisation	+		4 MeV	0,5 – 1	13 November 1970
	shrimps ●	radurisation	+			1	15 June 1976
	onions*	sprout inhibition	+			0,15 max	5 February 1971
	onions	sprout inhibition	+			0,05 max	9 June 1975



COUNTRY (Organisation)	PRODUCT	PURPOSE OF IRRADIATION	TYPE AND SOURCE OF RADIATION ^{60}Co	^{137}Cs	electrons	DOSE (kGy)	DATE OF APPROVAL
NETHERLANDS (continued)	poultry, eviscerated (in plastic bags)	radurisation	+			3 max	31 December 1971
	chicken	radurisation radicidation	+			3 max	10 May 1976
	fresh, tinned & liquid foodstuffs★	radappertisation	+			25 min	8 March 1972
	spices & condiments*	radicidation	+		4 MeV	8 – 10	13 September 1971
	spices**	radicidation	+		4 MeV	10	4 October 1974
	spices**	radicidation	+		3 MeV	10	26 June 1975
	spices**	radicidation	+			10	4 April 1978
	vegetable filling*●	radicidation	+			0,75	4 October 1974
	powdered battermix●	radicidation	+			1,5	4 October 1974
	endive● (prepared, cut)	radurisation	+			1	14 January 1975
	fresh vegetables● (prepared cut, soupgreens)	radurisation	+			1	6 September 1977
	fillets of haddock, coal-fish, whiting●	radurisation	+			1	6 September 1976
	fillets of cod & plaice●	radurisation	+			1	7 September 1976
	frozen frog legs**	radicidation	+			5	25 September 1978
	rice and ground rice products**	disinfestation	+			1	13 March 1979
PHILIPPINES	potatoes .	sprout inhibition	+			0,15 max	13 September 1972
SOUTH AFRICA	**potatoes**	sprout inhibition delayed greening	+			0,12 – 0,24	19 January 1977
	onions	sprout inhibition	+			0,05 – 0,15	25 August 1978
	garlic	sprout inhibition	+			0,1 – 0 20	25 August 1978
	chicken	radurisation radicidation	+			2 – 7	25 August 1978
	papaya	radurisation	+			0,5 – 1,5	25 August 1978
	mango	radurisation	+			0,5 – 1,5	25 August 1978
	strawberries	radurisation	+			1 – 4	25 August 1978
	dried bananas§	insect disinfestation	+			0,5 max	28 July 1977
	avocados§	delayed ripening	+			0,1 max	28 July 1977
SPAIN	**potatoes**	sprout inhibition	+			0,05 – 0,15	4 November 1969
	onions	sprout inhibition	+			0,08 max	1971
THAILAND	**onions**	sprout inhibition	+			0,1 max	20 March 1973
UNION OF SOVIET SOCIALIST REPUBLICS	**potatoes**	sprout inhibition	+			0,1	14 March 1958
	potatoes	sprout inhibition			1 MeV	0,3	17 July 1973
	grain	insect disinfestation	•			0,3	1959
	fresh fruits & vegetables*	radurisation	+			2 – 4	11 July 1964
	semi-prepared raw beef, pork & rabbit products (in plastic bags)*	radurisation	+			6 – 8	11 July 1964
	dried fruits	insect disinfestation	+			1	15 February 1966
	dry food concentrates (buckwheat mush gruel rice pudding	insect disinfestation	+			0,7	6 June 1966
	poultry, eviscerated (in plastic bags)*	radurisation	+			6	4 July 1966
	culinary prepared meat products (fried meat, entrecote) (in plastic bags)*	radurisation	+			8	1 February 1967
	onions*	sprout inhibition	+			0 06	25 February 1967
	onions	sprout inhibition	+			0,06	17 July 1973
UNITED KINGDOM	any food for consumption by patients who require a sterile diet as an essential factor in their treatment	radappertisation					1 December 1969
UNITED STATES OF AMERICA	**wheat and wheat flour** (changed on 4 March 1966 from wheat and wheat product)	insect disinfestation	+			0,2 – 0,5	21 August 1963
			+			0,2 – 0,5	2 October 1964
					5 MeV	0,2 – 0,5	26 February 1966
	white potatoes	sprout inhibition	+			0,05 – 0,1	30 June 1964
				+		0,05 – 0,1	2 October 1964
			+	+		0,05 – 0,15	1 November 1965
URUGUAY	**potatoes**	sprout inhibition	+				23 June 1970



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COUNTRY (Organisation)	PRODUCT	PURPOSE OF IRRADIATION	TYPE AND SOURCE OF RADIATION			DOSE (kGy)	DATE OF APPROVAL
			^{60}Co	^{137}Cs	electrons		
WORLD HEALTH ORGANISATION (FAO/IAEA/WHO Expert Committee)	potatoes☆	sprout inhibition	+	+		0,15 max	12 April 1969
	potatoes	sprout inhibition	+	+	10 MeV max	0,03 – 0,15	7 September 1976
	onions §	sprout inhibition	+	+	10 MeV max	0,02 – 0,15	7 September 1976
	papaya	insect disinfestation	+	+	10 MeV max	0,5 – 1	7 September 1976
	strawberries	radurisation	+	+	10 MeV max	1 – 3	7 September 1976
	wheat & ground wheat products☆	insect disinfestation	+	+	10 MeV max	0,75 max	12 April 1969
	wheat & ground wheat products	insect disinfestation	+	+	10 MeV	0,15 – 1	7 September 1976
	rice §	insect disinfestation	+	+	10 MeV max	0,1 – 1	7 September 1976
	chicken	radurisation radicidation	+	+	10 MeV max	2 – 7	7 September 1976
	cod & redfish §	radurisation radicidation	+	+	10 MeV max	2 – 2,2	7 September 1976

* experimental batches
☆ *temporary acceptance*
★ hospital patients
● test marketing
§ provisional
bold: unlimited clearance (*unconditional acceptance*: WHO)

Kindly supplied by Dr J C van Kooij
Head: Food Preservation Section
Joint FAO/IAEA Division of Atomic Energy in Food and Agriculture, Vienna, Austria.