



# Report of the Task Group on Fermentation Technology

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SOUTH AFRICAN NATIONAL SCIENTIFIC PROGRAMMES REPORT NO

31

SEPTEMBER 1978

Compiled and issued by  
Cooperative Scientific Programmes  
Council for Scientific and Industrial Research  
P O Box 395  
PRETORIA 0001  
from whom copies of reports in this series are available on request

Printed in 1978 in the Republic of South Africa  
by the Graphic Arts Division of the CSIR

ISBN 0 7988 1408 X

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2. \*Sensitivity analysis of a simple linear model of a savanna ecosystem at Nylsvley. W M Getz and A M Starfield. December 1975. 18 pp.
3. \*Savanna Ecosystem Project - Progress report 1974/1975. S M Hirst. December 1975. 27 pp.
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31. Report of the Task Group on Fermentation Technology. R J Andrews, J A de Villiers, P M Lategan, F G Neytzell-de Wilde and J P van der Walt. September 1978. 16 pp.

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PREFACE

An ad hoc meeting held in Bloemfontein on 29th November, 1976, identified a need for greater contact between South African research groups involved in fermentation technology. The meeting also suggested that the stimulation of research and training of microbiologists should receive further attention.

At a meeting held on 14th April, 1977 the Committee for Solid and Toxic Wastes considered the report of the Bloemfontein ad hoc meeting, and appointed a Task Group on Fermentation Technology to report on the facilities and needs of the South African fermentation industry, with economic and strategic implications, and submit recommendations on areas where further research was required. The Task Group was requested to pay specific attention to the potential for single cell protein production and the production of the other strategic products by fermentation.

The members of the Task Group were as follows:

|                           |   |
|---------------------------|---|
| Prof D R Woods (Chairman) | - Rhodes University                       |
| Mr R J Andrews            | - C G Smith & Co Ltd                      |
| Mr J A de Villiers        | - Techno-economic Studies Group, CSIR     |
| Prof P M Lategan          | - University of the Orange Free State     |
| Dr F G Neytzell-de Wilde  | - University of Natal                     |
| Mr H J van der Merwe      | - Cooperative Scientific Programmes, CSIR |
| Dr J P van der Walt       | - Microbiological Research Group, CSIR    |

INTRODUCTION

The Task Group met in June and August, 1977. At its first meeting it was decided that members of the Task Group would visit fermentation research centres in the country and that all aspects of fermentation would be included.

The following subdivision of responsibilities were agreed upon:

- |                      |   |
|----------------------|---|
| Prof Woods           | - all industrial and university groups in the eastern and western Cape, the University of the Witwatersrand, and all beer and wine industries.  |
| Mr Andrews           | - all industrial, (including pharmaceutical) groups outside the eastern and western Cape with particular emphasis on single cell protein and effluent production which could yield possible fermentation substrates |
| Mr de Villiers       | - techno-economic assessments with a view to identifying key areas  |
| Prof Lategan         | - the Universities of Pretoria, Potchefstroom, and the Orange Free State and the Rand Afrikaans University  |
| Dr Neytzell-de Wilde | - the university groups in Natal  |
| Mr van der Merwe     | - coordinator of activities and compilation of formal report in collaboration with the chairman   |
| Dr van der Walt      | - all CSIR groups   |

It was also agreed that all information would be collected in the following format:

1. Institutions visited or source from where information was obtained.
2. Present work being done in the field of fermentation
  - What is being done?
  - By whom?
  - What facilities are available with particular regard to continuous and batch fermenters?
  - Are the facilities (in the opinion of the surveyor) adequate for the work done?

Planned research in the field of fermentation

- What research is planned for 1978-1981?
- Would the institution like to get involved in fermentation work in the foreseeable future?
- What research would the institution like to see done (apart from those activities that would definitely take place)?

At the second meeting the Task Group discussed, in the light of the results of the survey, which research needs to be recommended for further support and coordination.

SURVEY RESULTS

This section reflects the details of the reports submitted by Task Group members and includes factual information rather than opinions expressed.

Rand Afrikaans University

Department of Chemistry

(Prof R R Arndt and Prof C W Holzapfel)

Interested in the development of analytical techniques for the fermentation industry.

Projects in progress and planned for the 1978/1981 period include studies of the presence of mono- and tri-saccharides in wort and the effect of pretreatments on their occurrence in wort, nitrogen containing substances during the washing process and the influence of time on the composition of these materials, the influence of the use of other starch sources other than barley on the poly-saccharide content of the pre-fermented wort, and gas chromatographic identification of contaminants affecting the taste of the brew end-products. It is essential that chemical techniques exist for the fermentation industry for process and quality control. Knowledge should also be available on suitable chemical extraction and purification techniques. Graduate students in the fermentation industry should come into contact with analytical techniques.

University of the Witwatersrand

Department of Botany and Microbiology

(Dr E Lawson, Dr D Rawlings and Dr N E Tonhazy)

Staff of the Department have had considerable experience in the microbiology of industrial and domestic effluent treatment processes and are actively seeking for cooperative work with industry in other



fermentation studies. Representations are being made to various sources for the acquiring of fermentation equipment in order to broaden the scope of research currently being carried out.

At the moment an investigation on the microbiology of the removal of phosphate from sewage effluent is in progress, in collaboration with the Johannesburg Municipality. This has led to some interesting results. In addition, research on metabolism and antibiotic production of actinomycetes is to be initiated.

Homemade continuous culture equipment is available and being used in these studies but more sophisticated fermentation equipment and a continuous action centrifuge is being sought.

### University of Pretoria

#### Department of Microbiology (Prof P L Steyn and Mr A D Botma)

Work is being done on the production of bacteria causing contagious abortion in horses for the preparation of vaccine by Onderstepoort. A project on the production of an anti-fungus antibiotic using Bacillus subtilis has been planned for the 1978/1981 period. Research on the application of microbial leaching on the recovery of low-grade uranium and gold ores has also been planned for 1978/1981 as well as on the production of single cell protein from whey and the enzymatic hydrolysis of lactose in whey.

The available facilities are as follows: A 3 x 14 l New Brunswick fermenter with no instrumentation. This is an old instrument. A 1 x 600 ml New Brunswick continuous flow fermenter with instrumentation. Full instrumentation on the existing 3 x 4 l fermenter will be necessary or a new 3 x 4 l batch fermenter with full instrumentation will have to be obtained for possible future work on the production of methane from organic wastes and the production of ethanol by fermentation.

### University of Natal

#### Departments of Biochemistry and Microbiology - Plant Pathology, Pietermaritzburg

(Dr R F H Dekker, Dr H Schwartz (Onderstepoort), Prof G Quicke and Dr F M Wallis)

In the Department of Microbiology-Plant Pathology honours students are examining the production of acetic acid from ethanol using a continuous culture fermentation technique.

A screening programme for the detection of possible new antibiotics has led to the discovery of an antibiotic showing both antifungal and broad

spectrum antibacterial activity. Work is in progress on its isolation and identification.

In the Department of Biochemistry work on the growth of Hyphomicrobium on nitrate containing industrial effluents with methanol as C-source, in order to remove nitrates has been successfully completed. Biomass was also assessed for nutritive value and possible value as single cell protein. (1 Ph.D. student).

A recent development has been the initiation of a collaborative programme between these two departments, with support from the CSIR Cooperative Scientific Programmes, aimed at finding useful sources of fungal and/or bacterial cellulases and hemicellulases which may be exploited in the biodegradation of bagasse or other agricultural cellulosic wastes, to yield glucose and xylose, respective substrates for the production of power alcohol and furfural. The Department of Microbiology and Plant Pathology is screening fungi and bacteria for cellulolytic and hemicellulolytic enzymes (1 Honours and 1 Masters candidate). The most promising isolates are passed on to the Department of Biochemistry which is undertaking the isolation and characterisation of the relevant enzymes (1 Ph.D. candidate, 2 Masters and 1 Honours). Good progress has been made on the optimisation of conditions for optimal growth and enzyme production. A number of enzymes have been located including xylanases, galactanases, mannanases and several cellulolytic enzymes and these are presently being fractionated. When purified, the enzymes will be more closely studied with respect to their physico-chemical properties including kinetics of hydrolysis and mode of action.

Work is also in progress in the Department of Biochemistry on the polysaccharide degrading enzymes of rumen bacteria with particular attention to the hemicellulases. This project is being carried out in collaboration with Dr Helen Schwartz of the Digestion and Metabolism Research Unit, Onderstepoort.

In view of the heavy teaching commitment of the staff of both cooperating departments the full time services of a well trained technician or graduate is regarded as deserving high priority. As far as training is concerned microbiology students are given a course in industrial microbiology where the emphasis is placed on fermentation, including the theory and application of batch and continuous culture methods. Students should thus be in a position to participate in industrial activities involving fermentation, particularly if they could work with an experienced person for a few weeks to familiarise themselves with large scale plant work etc.

As far as the biochemistry students are concerned, a few graduates take an introductory course in microbiology. They are not well equipped for work in industrial fermentation but have the background to benefit from in-job training.

Twelve students were completing B.Sc. with microbiology as a major in 1977. Eight are returning for further study and four are available to

go into industry. There are 23 students completing B.Sc. and seven completing honours with biochemistry as a major. Only a few had some exposure to microbiology.

Adequate facilities are available for batch culture. For continuous culture the Department has at its disposal a New Brunswick Bioflo model C30 bench-top chemostat suitable for both aerobic and anaerobic cultures, turbidostat, pH controller and dissolved oxygen controller accessories. The working volume is only 350 ml with medium and product reservoirs of 13,3 l capacity. As presently set up at the flow rate of 350 ml per hour it can only be run for 38 hours. For the work on nitrate removal from industrial wastes an unsophisticated continuous culture system was built up with the aid of the Chemical Engineering Workshop.

The continuous culture facility is adequate for teaching purposes and for preliminary research investigations on the determination of various growth parameters. It would not be suitable for production of cells on a larger scale. In view of increasing demand for this facility it will be necessary to acquire at least one small service unit and a larger fermenter. Both Departments would like to become involved in more projects in the future. These are namely the possible production of lignin degrading enzymes from wood rotting fungi with a view to pre-treatment of bagasse for subsequent fermentation to alcohol, the expansion of the work on bagasse includes a source of enzymes for hydrolysis of hemicelluloses to pentose sugars especially xylose, and the production of single cell protein from agricultural wastes such as chicken manure, crop residues and dairy wastes. Expansion of the facilities for continuous culture work would be necessary. The major items needed are a second New Brunswick Bioflo model C30 chemostat (basis unit only plus electrodes), a larger chemostat, New Brunswick Microferm 7,5 l basic unit plus electrodes (it is possible to adapt this model to take a 14 l fermenter if scale-up to this size becomes necessary) and a high pressure liquid chromatograph for characterisation of the breakdown products of cellulose and hemicellulose degradation.

Department of Chemical Engineering, Durban  
(Dr F de Wilde)

This department is concerned mainly with effluent treatment involving physico-chemical as well as biological techniques. These could be extended into the energy field e.g. cellulose to alcohol.

Department of Food Technology, Durban  
(Dr H J H de Meulenare)

This institute is not engaged in fermentation technology as such but is however doing work on the removal of DNA and RNA from yeasts. It is also busy with work on the enriching of protein from yeast fodder.

University of Durban-Westville

Department of Microbiology

(Dr H L Lloyd)

Research has been planned for 1978/1981 on the development of a low cost unsophisticated system for moderate protein enrichment (up to c. 10% of fibrous sugar industry by-products to provide a stock feed base).

The Department would like to have more interest in single cell protein. Approximately 15 to 20 graduates, adequately trained, leave per year but they seem to favour medical laboratories. Only three to four post graduates succeed in obtaining the Honours standard every year. Students who succeed in obtaining a Masters degree number one or two per year.

This Department has good facilities among them a Magnaferm (Brunswick) 14 l fermenter. It is planned to use this fermenter in the continuous mode. The department would like to become involved in single cell protein work but facilities for this have not yet been finalised.

University of the Orange Free StateInstitute for Environmental Sciences

(Prof D F Toerien and Dr J U Grobbelaar)

Work is currently being undertaken on the mass cultivation of algae as a potential food source and the potential use of non-sulphur purple bacteria in the conversion of wastes material to food sources.

Current research projects will be continued in the period 1978/1981. One of the most important problems in the economic utilisation of single cell protein production is the harvesting of produced materials. If the microbial cells can be converted to higher organisms such as invertebrates or fish these difficulties may be overcome.

The Institute is very interested in undertaking further research of a fermentation technology nature but it is limited by a lack of suitable manpower, especially the services of bacteriologists and zoologists.

The following facilities are available. A small pilot-scale production unit for algal growth, a centrifuge for algal harvesting, extensive apparatus for chemical analysis of cations, anions and plant nutrients. The equipment of the Department of Microbiology is also used in the study of a photosynthetic bacteria. Facilities are regarded as adequate.

Department of Microbiology

(Prof P M Lategan, Prof H J Potgieter, Mr J C du Preez, Dr B A Prior, Mr S J Killian, and Mr C T Rudlow)

Research is being carried out on the production of single cell protein from fatty acids and alcohol with Acinetobacter on SASOL effluent, and

brewery and food canning factory effluent. The identification of industrial micro-organisms and yeasts with gas chromatographic, physiological and serological techniques is undertaken. Bacterial contaminants in beer are also identified.

Continuation of existing research is foreseen. Other industrial effluents will be investigated for single cell protein production. The department will also study the use of ethanol and other effluents for the production of other fermentation products. Fermentation research is hampered due to a lack of professional assistance. This department urgently requires additional research workers.

The following apparatus is available for current research. One 3 x 14 l Viritis fermenter with instrumentation, two 600 ml continuous culture fermenters with instrumentation for volatile compounds, two gas chromatographs with electronic integrators and two refrigerated centrifuges. The following equipment is on order: six glass fermenters with controls in pilot plant for brewing of beer, a programable refrigerated water bath and a gas analyser for beer pilot plant.

The following equipment is required for 1978. One 7-20 l continuous fermenter with instrumentation, one CO<sub>2</sub> analyser, one oxygen analyser, one chemostat, one controlled water bath, five shaking machines and one refrigerated continuous flow centrifuge.

Equipment needed for 1979 is as follows. A cell density meter (Fundalux) plus recorder, a chemical antifoam control, a 20 l flask for the fermenter, a Niro spray drier and an auto analyser.

These facilities are considered adequate if items on budget are approved and future requirements fulfilled.

The Department is keen to undertake more research on single cell protein production and other fermentation products. For this they will need a big industrial pilot fermenter of c. 1500 l with all controls suitably situated and operated.

### Rhodes University

Department of Microbiology  
(Prof D R Woods and Dr F Robb)

Genetic and molecular biology studies are being undertaken on industrially significant micro-organisms. Studies are aimed at increasing the yields of the required products. These studies, in particular, are on the production of acetone and butanol by Clostridium acetobutylicum in collaboration with National Chemical Products (Pty) Ltd. Genetic and biochemical studies on brewing yeast are also being undertaken in collaboration with South African Breweries.

There will be a continuation of genetic and molecular biology studies on industrially significant micro-organisms with particular regard to the production of enzymes, e.g. cellulose, and collagenase and other proteases. Use will be made of the latest genetic engineering techniques to obtain relaxed plasmids which have been shown to increase enzyme yields by c. 500 fold. The Department would like to become involved in genetic and molecular biology aspects of fermentation research.

The Department trains genetically and biochemically orientated microbiologists. As can be seen from the research projects the Department is involved in industrial microbiology research which flavours the undergraduate courses.

The Department possesses two New Brunswick batch fermenters and consider these adequate for research except for a few accessories which are required.

#### University of Fort Hare

##### Department of Biochemistry

(Mr J S S Gray, Dr J Mildenhall and Mr D S du Toit)

Work is being done on the conversion of pure cellulose by Trichoderma viride to single cell protein.

Future research would be desirable on the conversion of maize residues by Trichoderma viride and the analysis of products from Trichoderma viride fermentation.

The Department draws on their own staff and employs two post graduate research students.

This Department has at its disposal two continuous New Brunswick fermenters and one New Brunswick batch fermenter. This equipment is regarded as adequate and further equipment for future research will not be required. The Department expresses a need for an auto-analyser due to the shortage of technical staff.

#### University of Stellenbosch

##### Department of Microbiology

(Prof M A Loos and Mr N F Schoombee)

No fermentation research as such is being done but there is considerable contact with the wine and brewing industries in the Western Cape. The Department assists with ad hoc problem solving, e.g. lactic acid bacteria.

There is no planned future research in fermentation but the Department will maintain an interest in the problems of wine making with particular regard to lactic acid bacteria. An interest is currently being developed in yeasts.

Department of Oenology  
(Prof C J van Wyk)

The continuous evaluation of fermentation is needed as an essential tool in the making of wine. Research on the fermentation process itself is undertaken, e.g. the evaluation of new grape varieties or yeast strains.

This Department will continue doing research on the making of wine.

The Department head sees a need and opening for oenologists with a good chemical and microbiological background in cellar management, quality control, etc. There is virtually no need for students to specialise in fermentation technology as research openings are limited. It is suggested that the best and most economic way of training the odd person required in the wine industry in this field is to either send him overseas or to make provision for a special curriculum for a microbiology or oenology B.Sc. Hons. student who wishes to specialise in the field of fermentation technology. The c. 10 graduates per year in oenology at Stellenbosch seem to be adequate for the demand of the wine industry and the research activities of the few cellars (e.g. Stellenbosch Farmer's Winery, KWV, Distillers) undertaking research. There is no remarkable growth at present in the industry.

Facilities are available for wine fermentation, for example, use is made of glass vessels (1 gallon jars) and 'Schweppes' pressure vessels.

Oenological and Viticultural Research Institute  
(Mr A Tromp)

The fermentation of grape musts into wines is scientifically served by three sections of the OVRI: Microbiology, Cellar Technology and Wine Chemistry.

In the Microbiology Section research is done on wine fermentation in the following fields:

- Active dried wine yeast: Its effect on wine quality and technological characteristics.
- The effect of nitrogen, SO<sub>2</sub> and other compounds on fermentation.
- Isolation of new yeasts.
- Effect on fermentation of fungicides used to control vine diseases.

Further research is being done on the microbiology of finished wines. The malolactic fermentation process which can lead to disorders if not handled correctly is currently the topic of intensive research.

This section also handles any commercial microbiological problem with which it is confronted and renders assistance and gives advice in this respect. The Microbiology Section also supplies yeasts to 30 out of c. 200 cellars. The rest of the cellars seem to be supplied by Anchor Yeast (Pty) Ltd. The section is in possession of a 14 l New Brunswick continuous culture fermenter with O<sub>2</sub>, pH control etc. Excellent facilities exist for small scale batch wine fermentation.

A pilot plant may be considered for yeast production but problems may arise because of the distance between Stellenbosch and Pretoria if it is situated at the CSIR.

The Cellar Technology Section does directed research on cellar equipment and evaluates their oenological, economical and engineering qualities. Apart from this it aids amongst other sections the Microbiology Section in testing small scale results on a larger scale which is closer to commercial scale cellar practices.

The Wine Chemistry Section is concerned with research regarding the final product, and generates results which help the Microbiology Section to select for instance the correct yeast to obtain the best wine quality in the finished product.

## CSIR

### Microbiology Research Group

(Dr J P van der Walt and Dr N P Ferreira)

Research is carried out to produce citric acid.

Upon completion of the existing research further projects would be considered to convert (through microbial action), raw materials to products with high market values and sufficient demand.

### Sorghum Beer Unit

(Dr T G Watson)

This unit is actively engaged in aspects of fermentation technology relating to the sorghum beer industry. The current research programme includes the study of amino acid requirements of industrially important yeasts, nitrogen requirements of lactic acid bacteria and the possible improvement of sorghum beer wort by the addition of enzyme preparations.

Although the unit is a little short on space, it is well equipped and has two 5 l New Brunswick fermenters. A third instrument is on order. The programme for 1978/1981 is again geared to serve the industry and will include the study of alcoholic fermentation by batch and continuous



technique, the development of new brewing processes using microbial enzymes, the study of the influence of pure selected brewing yeast cultures on quality, the study of lactic acid fermentation as a brewing process, the industrial sterilisation of sorghum beer wort and the production of yeast cake for brewing purposes. This programme will be undertaken by the staff of the unit. Existing facilities are adequate but future studies will require larger fermenter types. The successful development of the unit's programme depends very much on the availability of space for larger fermenter vessels with the associated ancillary services.

The unit serves a multimillion rand industry very adequately. The envisaged programme for 1978/1981 is decided upon in consultation with the industry and is designed to meet the industry's requirements. Personnel of the unit, in collaboration with the Pretoria College for Advanced Technical Education are actively engaged in the training of brewers. This training programme appears to meet the needs of the industry quite adequately.

#### National Institute for Water Research

The Institute's interests which may be related to fermentation technology cover the anaerobic digestion and fermentation of factory effluents with high organic residues, with special reference to the wine and canning industries, anaerobic digestion of effluents from animal feed processing plants and poultry batteries, and the biological removal of phosphates from urban effluents. This work is undertaken by members of the Institute in general and adequate facilities for both batch and continuous cultures are available.

Over the period 1978/81, apart from the continuation of current projects, the investigations on the microbial conversion of cellulosic wastes (water hyacinth) to methane and fermentable carbohydrates, are envisaged.

The Institute would like to see more work done on the microbial conversion of cellulosic wastes, for which it is adequately equipped. Water biologists and water chemists, rather than microbiologists or fermentation technologists, are appointed.

#### Cyanamid

(Mr B Harrington and Mr A Torrance)

Work is being done on tetracycline production by batch process, but no actual fermentation research is undertaken in South Africa.

No fermentation research is currently planned for South Africa. Research on fermentation technology and strain selection is carried out overseas.

The company has a demand for biochemically orientated microbiologists and biochemical engineers.

Intercontinental Breweries

(Mr B Stuartson, Mr J Aiken and Mrs Vorster)

The only research currently being undertaken is in connection with day to day problems and quality control.

At the present moment research is currently only undertaken on the day to day problems. Due to the expansion of this group and the dire need for qualified people it has not been possible to embark on more sophisticated research for the immediate future.

The need for brewers can only be met by recruiting staff overseas. The employment of graduates, who are to be trained as brewers, is preferred, but many of these graduates are not always prepared to accept a period of apprenticeship and/or do shift work.

Miles Laboratories (Pty) Ltd

(Dr J Largier, Mr D Benson, Dr P Celliers and Mr D MacCullum)

The firm is interested and equipped for the production of enzymes from animal and plant sources.

There is at present no planned research in the fermentation field in South Africa. Bacterial enzymes are produced by the company in the USA and Germany. The economics of bacterial enzyme requirements for South Africa do not justify the construction of a fermentation plant. However, the firm is interested in collaborating with companies active in the fermentation field. Miles would be interested in purifying enzymes from bacteria or media which had been produced in a fermentation plant elsewhere.

The firm requires graduates in microbiology and biochemistry. They have no requirements for fermentation technologists. Good facilities are available for research and the production of enzymes.

South African Breweries

(Dr J Murray and Mr D Ryder)

Apart from the brewing of beer, the utilisation of effluent for single cell protein is being investigated in collaboration with the Department of Microbiology, University of the Orange Free State. Studies on yeast genetics and biochemistry in collaboration with the Department of Microbiology, Rhodes University, are also being undertaken.

Work will be continued on projects in connection with brewing beer and yeast genetics and biochemistry. Research will also be done on new fermentation systems and technology for brewing.

South African Breweries sees a need for more qualified staff and would prefer biochemically orientated microbiology Honours graduates whom they

would train as brewers. They do not see a demand for first degree fermentation technologists. The quality control aspects are handled by school leavers who have been trained by South African Breweries themselves.

South African Breweries have a pilot plant (100 l) batch brewing system. No laboratory continuous culture apparatus is available.

## DISCUSSION AND RECOMMENDATIONS

### General

The survey reveals that there is a very small fermentation industry in South Africa. Products produced by fermentation include:

- (a) beer, wine, alcohol, vinegar and yeasts;
- (b) acetone, and butanol;
- (c) certain tetracyclines.

All the other products produced by fermentation (e.g. enzymes, antibiotics, amino acids, vitamins etc) are imported into South Africa with the consequent loss in foreign exchange. Some of these products are of strategic importance. As a result of the energy crisis, microbial fermentation will play an increasingly important role in the future and South Africa is unprepared for such developments. The Task Group felt that the development of fermentation industries in South Africa was feasible and should be encouraged. This could be done by encouraging either international or South African based companies to develop processes in this country. The latter is perhaps more realistic and at least one South African based pharmaceutical company is actively interested and engaged in developing the production of new fermentation products. It is felt that initially an industry based on judiciously chosen low bulk high cost products has the greatest chance of success and could compete without protection and be an export industry. This is important as the market for many fermentation products within South Africa is small.

### Manpower

In general there is and will be a demand for well-trained biochemically orientated microbiologists and chemical engineers in both industry and research. Post-graduate training in specialised aspects of fermentation is also required but the demand for such specialised graduates will have to be related to the development of fermentation industries. Industrialists in established fermentation firms differ in their preference for specialised graduates as opposed to 'in-house training' of suitable personnel. However, the development and construction of new fermentation industries will require microbial and biochemical engineers.

Mention should be made of the wine industry which expressed defined manpower requirements. A need is seen for biochemically orientated microbiologists and oenologists with a good chemical background in cellar management and research. Almost all groups involved in fermentation research suffer from a lack of manpower with a suitable engineering background and problems are experienced in trying to recruit such people. The cellar manager may take the B.Sc. agricultural degree majoring in oenology with courses in microbiology and biochemistry at the University of Stellenbosch. A diploma can also be attained at Elsenburg Agricultural College, as a background. These courses are regarded as very suitable for this category of manpower requirement and no advance training in fermentation technology seems to be required as cellars prefer 'in-house' training.

Limited research posts are available at the OVRI and at some of the larger wine firms. A short course in fermentation technology may be worthwhile but the number of participants will be small. The OVRI sets a B.Sc. Hons (agriculture) degree as a minimum educational standard for a professional officer but encourages the acquisition of a M.Sc. degree.

At the present time the numbers of graduates in oenology from Stellenbosch or diploma students from Elsenburg are adequate for the requirements of the wine industry and the research activities of the few cellars engaged in research. There is no growth at present in the industry. Although the wine industry seems to be in a happy 'steady state' it is difficult to establish whether both the breweries and wineries are keeping pace with overseas developments.

#### Pilot Plant Facilities

If a fermentation industry is to be developed in South Africa, a sophisticated pilot plant facility of c. 1500 l is required. It is recommended that such a facility should be housed at the CSIR in view of its position in relation to other industries on the Reef. It would be available to university, industrial and government groups and would hopefully serve to bring these groups closer together in the interests of the best utilisation of expertise and capital. The actual construction of the pilot plant could depend on the availability of promising processes. The cost of such a project would also have to include the necessary manpower to design, construct and maintain the facility. Few such people are available in South Africa and would in all probability have to be recruited from overseas.

#### Genetic Manipulation Techniques

Any developments in the fermentation industry should take cognisance of the latest developments in the techniques for the manipulation of genes. These techniques will have a great impact on the nature and product yields of industrially significant micro-organisms. (See Report of the Advisory Committee on Genetic Engineering). It should also be remembered that the initial isolation and improvement of strains will have to be done locally as international companies will not normally sell or give away their best strains.

### Fermentation Products and Areas for Cooperative Research

Relatively little fermentation research is being undertaken by South African groups and there is a need for a realistic cooperative research programme. The expertise within each of the small scattered South African university departments is limited and a collaborative approach is essential if success is to be achieved. Projects should be designed and motivated in a detailed and realistic manner. Much of the research envisaged by universities is of a fundamental nature which should be encouraged but the productivity of the research should be monitored by publication in well recognised international journals or by practical developments.

Details of areas of research and specific comments are as follows:

#### Beverages and yeasts

The established industries in South Africa in these fields do not undertake much basic research and are involved in 'trouble shooting'. They are in a position to establish collaborative projects with universities and should be encouraged to do so.

#### Alcohol and organic solvents

Alcohol and organic solvents will be increasingly required by industry and the development of new and improved fermentation processes is most important. The Task Group did not consider the implications of the use of alcohol for fuel but if such a decision is taken by Government then the utilisation of substrates other than sucrose must be investigated (see degradation of cellulose and single cell protein).

#### Enzymes, antibiotics, amino acids, vitamins and microbial conversions

None of these products (except for a few tetracyclines under licence) are produced in South Africa and some of the products should be developed as low bulk, high cost commodities. The production of antibiotics in South Africa should be encouraged but again it must be stressed that the micro-organisms would have to be isolated and improved locally.

#### Degradation of cellulose and single cell protein production

Reliable projections regarding all protein requirements for animal feeds until 1980 are available. A report entitled "Protein: the Requirements of the South African livestock industry during 1980" (J G Cloete, 1978), will be published by the end of the year by the Department of Agricultural Information, and can be regarded as a standard basis of information on all available proteins for the southern African region. There seems to have been a decline overseas in the development of single cell protein processes from hydrocarbons. However, the development of single cell protein for animal feeds should be developed on a local or regional basis where a suitable substrate is available (e.g. suitable effluent). Degradation and utilisation of cellulose may prove viable in the long term as a substrate for single cell protein, but at present much fundamental

work needs to be done on the production of cellulases and the initial treatment of plant material. If Government takes a decision to utilise alcohol as a fuel then the utilisation of sucrose and cellulose as a substrates for alcohol production is an urgent priority.

#### Effluent degradation

Effluent degradation and purification is an on-going research area which should be continued in collaboration with the Water Research Commission and the National Institute for Water Research. The use of effluents as a substrate for important by-products as well as microbial mass should be investigated.

#### NATIONAL COMMITTEE FOR FERMENTATION RESEARCH

The need in South Africa for collaborative research has already been stressed but at present there is no mechanism for the coordination of fermentation research in this country. The Task Group recommends the creation of a National Committee for Fermentation Research to coordinate and foster fermentation research in South Africa. The committee should be manageable and contain representatives from the CSIR, Universities, Government and Industry.