the demand for and supply of natural scientists in the republic of south africa in 1980

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THE DEMAND FOR AND SUPPLY OF NATURAL SCIENTISTS IN THE REPUBLIC OF SOUTH AFRICA IN 1980

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PREFACE

During 1971 the Institute for Manpower Research undertook a comprehensive survey of graduates with training in the natural sciences. Data obtained from this survey and other relevant information were used in this report about the demand for and supply of natural scientists in the RSA in 1980.

This report is the fifth in which the demand and supply situation for an occupation or group of occupations is scrutinized. Any estimate of future situations can in a certain sense be regarded, if not as a shot in the dark, as at least one in the twilight. Because of the uncertainties inherent in estimates of future situations, these estimates must be reviewed periodically. Only then can demand and supply studies, such as this one, be of value for planning purposes. To make such a review possible the Institute is compiling a comprehensive manpower data bank, and a follow-on survey, aimed at gathering information about the labour situation and income structure of graduates, was undertaken in 1973. The first occupation scheduled for reviewing is that of engineers.

To the nearly 7000 graduates who took part in the HSRC survey, a hearty word of thanks. Thanks are also due to the Editorial Department of the Institute for Information and Special Services for editing the report, and to the Institute for Statistical Research for the tabulations.

Prof. Roberts.

PRESIDENT

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OPSOMMING

In hierdie studie oor die vraag- en aanbodsituasie vir natuurwetenskaplikes in 1980 is van inligting uit 'n opname van natuurwetenskaplikes in 1971 en ander relevante inligting oor die arbeidsmag gebruik gemaak. Ramings van die vraag na 5 natuurwetenskaplike groepe word vergelyk met die produksie van natuurwetenskaplikes volgens groep en studieveld. Indien die huidige tendense voortduur, word 'n tekort aan natuurwetenskaplikes teen 1980 verwag.

SUMMARY

This study on the demand and supply situation for natural scientists in 1980 uses information from a survey of natural scientists undertaken in 1971, and other relevant labour force information. Estimates of the demand for natural scientists by 5 major scientist groups are compared with the production of scientists according to group and field of study. The estimates lead to the conclusion that shortages of natural scientists could be expected by 1980 if present trends continue.

THE DEMAND FOR AND SUPPLY OF NATURAL SCIENTISTS IN THE REPUBLIC OF SOUTH AFRICA, 1980

CHAPTER 1

INTRODUCTION

Modern technological society has become increasingly dependent on the skills and talents of its natural scientists and engineers. Technology and technological change have an effect on every individual, and also on broader issues at national level. New scientific knowledge is usually freely available but the techniques and processes based on such know= ledge are, for a variety of military, economic and political reasons, often very closely guarded secrets. This situation necessitates a research and development action in every modern country because neither the product nor the know-how can always be bought. The Republic is a case in point. Because of the international political situation South Africa must develop its own guided missiles for example and has to do its own research in this regard. This would have been impossible had it not been for an established research tradition. Research cannot be undertaken in a vacuum and the available scientific knowledge can only be assimilated when a continuous research action and therefore the production of new knowledge is an established fact. The new knowledge to be assimilated and areas of know= ledge that must be covered are still increasing at a rapid pace. The result is that the demand for scientists has increased rapidly in the past and it is imperative for the future of South Africa that this demand be met. In South Africa the com= mon pool of the more intelligent school-leavers from which the future engineers, doctors, scientists of all descriptions, ad= ministrators, etc. are drawn, is limited and as a result govern= ment and industry have become concerned about the future man= power situation and have increasingly sought information on which to base plans of action. This report attempts to provide such information by presenting estimates of the demand and sup= ply situation of natural scientists in 1980. Because the num= ber of Non-Whites presently employed as natural scientists are negligible this report deals with Whites only.

The estimates presented in this report are projections of the courtry's needs in 1980 under a certain set of assump= tions rather than a projection of actual employment. The step by step procedure by which these estimates have been arrived at, is described in the text so that evaluation of the estimates is possible and all assumptions are spelled out.

The framework of the report is as follows:

As a study on the demand and supply situation for an occupation is hardly possible without knowledge of the present incumbents of that occupation, Chapter 2 gives a short description of the present corps of natural scientists. More detailed information is available in the HSRC's publications (1, 2, 3, 4 and 5) in which the various groups are described in detail.

Chapter 3 gives the estimates of the demand for natural scientists in 1980 and the implications the estimated demand has for training (supply) is discussed in Chapter 4. In Chapter 5 estimates of the supply of natural scientists are presented and in Chapter 6 demand and supply are compared. Chapter 7 is a summary of the main findings.

CHAPTER 2

THE NATURAL SCIENTISTS IN THE RSA, 1971

2.1 INTRODUCTION

This chapter gives a description of the natural scientists according to aspects which are involved in both supply and demand. The information was obtained by means of a survey undertaken in 1971. The method used for this survey is described in detail in the previously published reports mentioned on page 1, and only a short synopsis will be given here. From the National Register of Natural and Social Scientists the names and addresses of 9359 White persons who have had training in the natural science field were obtained. This group either practised one of the natural science occupations or was in possession of a degree with one or more natural science majors. Persons in possession of natural science diplomas which can be regarded as equivalent to a degree were included,but persons with occupationally directed degrees such as medicine, engineering, agriculture or dietics were excluded

Questionnaires were posted to the 9359 persons and 6710 (71,7%) completed questionnaires were received back. The survey group of 6710 persons was shown to be a representative sample of persons with natural science degrees in the Republic of South Africa.

2.2 OCCUPATIONAL STRUCTURE OF GRADUATES IN NATURAL SCIENCE

Graduates in the natural sciences practise a wide variety of occupations (Table 2.1). Only 31,0 per cent are active in an occupation which can be regarded as a natural science occupation i.e. the first five mentioned in Table 2.1. An occupational group accommodating a large number of graduates is the teaching profession and nearly 30 per cent of the graduates are either teachers or university personnel. Quite a number (732 or 14,6%) of male natural science graduates eventually find themselves in managerial positions. The table also shows that 13,9 per cent of the graduates are active in other than the above-mentioned occupations. Some, after obtaining a degree in natural science, either chose another field of study or move into more applied scientific occupations. Among the survey group there were 73 engineers, 87 metallurgists and also small groups of doctors, dentists and pharmacists. The relative large number of economists and accountants need some explanation. Mathematics and mathematical statistics were viewed as natural science majors for the purposes of this survey because these subjects are mostly taken by persons who pursue a natural science field of study. Persons

with major subject combinations such as mathematics and econo= mics or mathematical statistics and accountancy were therefore also included in this survey. A small number of persons with combinations such as mathematics and psychology and who now are psychologists were included in the same way.

TABLE 2.1

OCCUPATIONAL STRUCTURE OF SURVEY GROUP BY SEX

Occupational group	Male		Female		Total	
	N	%	N	%	N	%
Natural scientists:						
Earth scientists	284	5,7	13	0,8	297	4,4
Biologists	475	9,5	139	8,2	614	9,2
Chemists	508	10,1	65	3,8	573	8,5
Physicists	151	3,0	11	0,6	162	2,4
Mathematicians	335	6,7	97	5,7	432	6,4
Subtotal (natural scientists)	1753	35,0	325	19,1	2078	30,9
Teaching occupations:						
Teachers	820	16,4	375	22,0	1195	17,8
Lecturers/Professors	639	12,8	93	5,5	732	10,9
Others	53	1,1	7	0,4	60	0,9
Managerial and administrative occupations	732	14,6	21	1,2	753	11,2
Engineers	73	1,5			73	1,1
Metallurgists	87	1,7			87	1,3
Technicians	26	0,5	6	0,4	32	0,5
Farmers	75	1,5	1	0,05	76	1,1
Economists and Accountants	143	2,9	10	0,6	153	2,3
Legal occupations	30	0,6			30	0,4
Other human scientists	121	2,4	39	2,3	160	2,4
Others(doctors, dentists, clerks, etc.)	139	2,8	47	2,8	186	2,8
Subtotal (economically active)	4691	93,8	924	54,35	5615	83,6
Persons outside the labour market:						
Housewives			707	41,5	707	10,5
Post-graduate students	212	4,2	44	2,6	256	3,8
Retired persons	81	1,6	20	1,2	101	1,5
Unemployed	9	0,2	9	0,5	18	0,3
Others	13	0,3			13	0,2
Subtotal (not economically active)	315	6,3	780	45,8	1095	16,3
GRAND TOTAL	5006	100	1704	100	6710	100

Table 2.2 supplies more detail on the occupational composition of the 5 natural science occupational groups. It is appreciated that technicians are not scientists but rather supporting personnel for scientists. All these technicians are graduates however, and because many of the institutions which employ graduate technicians regard these technicians, especially the men, as potential scientists, the small number of technicians were included in the analyses.

TABLE 2.2

OCCUPATIONAL STRUCTURE OF NATURAL SCIENTIST GROUPS BY SEX

Occupational group and occupations	Male	Female	Total
Earth scientists:			
Geologists	247	8	255
Geophysicists	23	2	25
Mineralogists	7		7
Geochemists	5	1	6
Geographers and Technicians	2	2	4
Subtotal	284	13	297
Biologists:			
Biochemists	43	20	63
Biologists	54	10	64
Zoologists	63	15	78
Entomologists	47	7	54
Microbiologists	40	24	64
Botanists	45	28	73
Physiologists	17	7	24
Soil Scientists	10		10
Hydrobiologists	15	2	17
Agronomists	12		12
Oceanographers	18		18
Plant Pathologists	16	1	17
Phytogenists (Plant breeder)	13		13
Food Technologists	18		18
Weed Officials	8		8
Nature Conservators	5	1	6
Biometricians/Geneticists	5	2	7
Biological Technicians	9	7	16
Other occupations (with frequency < 5)	37	15	52
Subtotal	475	139	614

Table 2.2 continued

TABLE 2.2 CONTINUED

Occupational group and occupations	Male	Female	Total
Chemists:			
Chemists	465	62	527
Spectrochemists	2		2
Technologists (textile, paint, concrete, fuel, rubber, plastic)	31		31
Others	10	3	13
Subtotal	508	65	573
Physicists:			
Physicists	133	6	139
Meteorologists	15	3	18
Spectrographers	2	1	3
Physical Technicians	1	1	2
Subtotal	151	11	162
Mathematicians:			
Articled Actuary Clerks	30	1	31
Actuaries	50		50
Data Processing Officers	7	1	8
Programmers	55	60	115
Statisticians	68	20	88
Systems Analysts	101	12	113
Astronomers	1		1
Mathematicians	23	3	26
Subtotal	335	97	432
GRAND TOTAL	1753	325	2078

The rest of this Chapter deals with the pursuers of the natural science occupational groups. Because of small numbers, women working as physicists and earth scientists are not included in the following analyses.

2.3 AGE STRUCTURE

The natural scientists as a group are relatively young. Table 2.3 shows the median age for the various groups. Mathematicians are the group with the lowest median age. Table 2.2 showed that mathematicians are used extensively in the computer field as programmers, systems analysts and data processors. This involvement in a relatively new technological innovation is pro-

bably a reason for the low median age of mathematicians.

TABLE 2.3

MEDIAN AGE OF NATURAL SCIENTISTS BY GROUP AND SEX

Group	Medium age	
	Male	Female
Earth Scientists	34	
Biologists	32	28
Chemists	35	28
Physicists	33	
Mathematicians	29	25

2.4 LANGUAGE GROUP

Table 2.4 shows the composition of the survey group according to language group. The grouping is done on the basis of the language in which correspondence is preferred.

TABLE 2.4

LANGUAGE GROUP OF NATURAL SCIENTISTS BY GROUP AND SEX[1)]

Group		Language distribution					
		Afr.		Eng.		Total	
		N	%	N	%	N	%
Earth Scientists	M	133	46,8	151	53,2	284	100
Biologists	M	282	59,4	193	40,6	475	100
	F	64	46,0	75	54,0	139	100
Chemists	M	254	50,0	254	50,0	508	100
	F	23	35,4	42	64,6	65	100
Physicists	M	101	66,9	50	33,1	151	100
Mathematicians	M	155	46,3	180	53,7	335	100
	F	35	36,1	62	63,9	97	100

[1)] In some of the groups the number of women was too small for sensible analyses.

It would seem as if the two language groups have certain preferences for specific scientific fields. The relatively small number of English-speaking men among the Biologists and Physicists, and the fact that there are more English-speaking than Afrikaans-speaking women among all the occupational groups, are

interesting. It must be remembered that the ratio of Afrikaans- to English-speaking persons in the total population is roughly 6 to 4.

2.5 EMPLOYER

Job opportunities for the various groups (Table 2.5) are not proportionally distributed among the various employer categories. The institutions of the private sector are the most important employers of Earth Scientists and Mathematicians while Biologists and Physicists are usually employed by the government or semi-government institutions.

The very important role played by government and semi-government institutions in the employment of natural scientists is obvious.

2.6 GEOGRAPHICAL DISTRIBUTION

According to Table 2.6 more than 60 per cent of the natural scientists work in Transvaal. Earth Scientists and Chemists are concentrated in the Vaal Triangle and Biologists and Physicists in Pretoria. The relatively large number of Mathematicians in the Cape Province is partly due to the fact that a number of big financial institutions such as insurance companies have their head offices and data processing divisions in Cape Town.

2.7 QUALIFICATION LEVEL

Table 2.7 shows the quantification level for the various groups.

A remark on the category Diploma = B degree is necessary. These diplomas require matriculation for entry and at least 3 years post-matriculation study. The table shows such diplomas as being the highest qualification of 26 mathematicians. A large number of these are actuarial diplomas which are of a very high standard and require more than three years of study.

The table shows that natural scientists are indeed a very highly qualified group of persons. Masters and doctors degrees are common. The most highly qualified group is the Physicists of whom 65,6 per cent have either a M. or D. degree.

TABLE 2.5

EMPLOYER OF NATURAL SCIENTISTS BY GROUP AND SEX

Employer	Earth scien= tists		Biologists				Chemists				Physi= cists		Mathematicians			
	Male		Male		Female		Male		Female		Male		Male		Female	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Self-employed	11	3,9	1	0,2	1	0,7	5	1,0			1	0,7	14	4,2	2	2,1
Civil service, prov. admin. & local govern= ment	39	13,7	261	54,9	64	46,0	69	13,6	10	15,4	27	17,9	38	11,3	10	10,3
Semi-government	56	19,7	132	27,8	63	45,3	212	41,7	27	41,5	111	73,5	72	21,5	25	25,8
Private sector	178	62,7	81	17,1	11	7,9	222	43,7	28	43,1	12	7,9	211	63,0	60	61,9
TOTAL	284	100	475	100	139	100	508	100	65	100	151	100	335	100	97	100

TABLE 2.6

GEOGRAPHICAL DISTRIBUTION OF NATURAL SCIENTISTS BY GROUP AND SEX

Groups		Pretoria		Vaal triangle (including Sasol)		Rest of Transvaal		OFS (excluding Sasol)		Cape		Natal		SWA		Total	
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Earth Scientists	M	38	6,6	103	18,9	25	17,2	13	21,7	63	12,7	11	6,5	31	49,2	284	13,8
	%	13,4		36,3		8,8		4,6		22,2		3,9		10,9		100	
Biologists	M	137	23,7	51	9,4	69	47,6	21	35,0	128	25,8	56	33,3	13	20,6	475	23,1
	%	28,8		10,7		14,5		4,4		26,9		11,8		2,7		100	
	F	57	9,9	28	5,1	6	4,1	5	8,3	33	6,6	9	5,4	1	1,6	139	6,8
	%	41,0		20,1		4,3		3,6		23,7		6,5		0,7		100	
Chemists	M	137	23,7	171	31,4	23	15,9	9	15,0	98	19,7	61	36,3	9	14,3	508	24,7
	%	27,0		33,7		4,5		1,8		19,3		12,0		1,8		100	
	F	21	3,6	17	3,1	3	2,1	2	3,3	10	2,0	6	3,6	6	9,5	65	3,2
	%	32,3		26,2		4,6		3,1		15,4		9,2		9,2		100	
Physicists	M	84	14,6	29	5,3	7	4,8	3	5,0	25	5,0	3	1,8			151	7,4
	%	55,6		19,2		4,6		2,0		16,6		2,0				100	
Mathematicians	M	75	13,0	110	20,2	8	5,5	5	8,3	118	23,7	17	10,1	2	3,2	335	16,3
	%	22,4		32,8		2,4		1,5		35,2		5,1		0,6		100	
	F	28	4,9	35	6,4	4	2,8	2	3,3	22	4,4	5	3,0	1	1,6	97	4,7
	%	28,9		36,1		4,1		2,1		22,7		5,2		1,0		100	
TOTAL	N	577	100	544	100	145	100	60	100	497	100	168	100	63	100		100
	%	28,1		26,5		7,1		2,9		24,2		8,2		3,1		100	

TABLE 2.7

HIGHEST LEVEL OF QUALIFICATIONS OF NATURAL SCIENTISTS BY GROUP AND SEX

Level	Earth scientists		Biologists				Chemists				Physicists		Mathematicians			
	M		M		F		M		F		M		M		F	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Diploma = B.degree			1	0,2			13	2,6	2	3,1			26	7,8		
B.degree	92	32,4	143	30,1	81	58,3	234	46,1	41	63,1	29	19,2	203	60,6	72	74,2
Post-graduate diplomas	2	0,7	6	1,3	9	6,5	12	2,4	7	10,8	3	2,0	17	5,1	9	9,3
B.Hons. degree	77	27,1	88	18,5	18	12,9	64	12,6	8	12,3	20	13,2	38	11,3	8	8,3
M.degree	63	22,2	152	32,0	15	10,8	110	21,7	3	4,6	56	37,1	37	11,0	8	8,3
D.degree	50	17,6	85	17,9	16	11,5	75	14,8	4	6,2	43	28,5	14	4,2		
TOTAL	284	100	475	100	139	100	508	100	65	100	151	100	335	100	97	100
Percentage B.(Hons.) and above		66,4		69,4		35,2		69,1		23,2		78,8		29,5		16,6

CHAPTER 3

THE DEMAND FOR NATURAL SCIENTISTS

The data for the demand projections are derived from a variety of sources. Apart from data available from the survey described in Chapter 2, the Department of Labour's Manpower Surveys of 1965, 1967, 1969 and 1971 provided indispensable data for this study and these sources are used so frequently that unless specifically stated otherwise, data pertaining to the afore-mentioned years are from the sources named.

3.1 TOTAL DEMAND FOR WHITE LABOUR

Information received from the Division for Economic Planning of the Department of Planning provides the point of departure for the demand projection. Based on an annual growth rate of 5,75 per cent in the GNP this Division estimates the total demand for White labour in 1980 at 1 861 800. Table 3.1 shows the sectorial composition of this demand.

TABLE 3.1

ESTIMATE OF THE DEMAND FOR WHITE LABOUR IN 1980 BY INDUSTRY

	Industrial sector	Demand for labour
1	Agriculture, forestry and fishing	92300
2	Mining and quarrying	67900
3	Manufacturing and commerce	666400
4	Construction	81800
5	Electricity, gas and water	20700
6	Transport and communication	202800
7	Services and financing	729900
	TOTAL	1861800

3.2 TOTAL DEMAND FOR LABOUR BY SEX

The next step in the demand estimate is to reduce the total demand to a demand by sex. The male : female ratios in the White labour force in the various sectors and various years are shown in Table 3.2. The table also shows an estimate of the male : female ratio in 1980.

TABLE 3.2

SEX RATIOS FOR THE WHITE LABOUR FORCES BY INDUSTRY

Industrial sector		1960	1965	1967	1969	1970	1971	1980
Agriculture, forestry, fishing	M	97,0				95,3		95,3
	F	3,0				4,7		4,7
Mining and quarrying	M	95,6	95,5	95,5	95,1	93,2	93,0	93,0
	F	4,4	4,5	4,5	4,9	6,8	7,0	7,0
Manufacturing and commerce	M	70,2	66,3	67,6	66,7	68,7	66,8	66,8
	F	29,8	33,7	32,4	33,3	31,3	33,2	33,2
Building and construction	M	97,3	92,4	91,7	92,2	93,3	91,6	92,0
	F	2,7	7,6	8,3	7,8	6,7	8,4	8,0
Electricity, gas and water	M	94,3	93,8	93,6	93,6	90,7	93,2	92,0
	F	5,7	6,2	6,4	6,4	9,3	6,8	8,0
Transport and communication	M	86,2	88,5	88,2	87,4	84,6	86,0	85,0
	F	13,8	11,5	11,8	12,6	15,4	14,0	15,0
Services and financing	M	57,8	59,4	59,6	58,1	55,2	55,0	55,0
	F	42,2	40,6	40,4	41,9	44,8	45,0	45,0

A survey among women graduates (10) in 1970 showed that most of those graduates who wanted to work were working. Only 15 of a group of 2912 women were available for full-time employment. If this situation is also applicable to non-graduates, it can be reasoned that the participation of women in full-time employment has about reached its limit. The estimate for 1980 is therefore in agreement with the trend of the past, but is a conservative one.

Application of the estimated male : female ratios to the demand for labour by sector gives an estimate of the male and female labour forces in 1980. The result of this application appears in Table 3.3.

3.3 DEMAND FOR NATURAL SCIENTISTS

The next step is to decide what percentage of the estimated demand for labour will represent a demand for natural scientists. This step is obviously a very crucial one in the demand estimates, and it is perhaps necessary at this stage to mention the basic assumptions underlying the projections which follow. Other more specific assumptions will be discussed as they apply to certain aspects.

TABLE 3.3

THE DEMAND FOR WHITE LABOUR BY SEX AND SECTOR, 1980

Industrial sector		1980		
		E.O.P.	%	N
Agriculture, forestry and fishing	M	92300	95,3	87962
	F		4,7	4338
Mining	M	67900	93,0	63147
	F		7,0	4753
Manufacturing and commerce	M	666400	66,8	445155
	F		33,2	221245
Building and construction	M	81800	92,0	75256
	F		8,0	6544
Electricity, gas and water	M	20700	92,0	19044
	F		8,0	1656
Transport and communication	M	202800	85,0	172380
	F		15,0	30420
Services and financing	M	729900	55,0	401445
	F		45,0	328455
TOTAL		1861800		1861800

It is clear from the total demand figures and their source that a relatively high level of economic growth is assumed. A lower rate would limit the anticipated growth in demand and will therefore alter the demand/supply relationships. It is assumed that the scientific and technological advances of the recent years will continue and that research and development expenditures will continue at more or less the same rate as in the past.

It is also assumed that the private sector of the economy will still prefer to buy new innovations rather than undertake research and development of their own and that the other economic and social patterns will be about the same in 1980 as it is today.

The labour force for the years 1965, 1967, 1969 and 1971 in each of the industrial sectors mentioned in Table 3.3, with the exception of agriculture, forestry and fishing, was broken down into 19 separate occupational groups for men and women. It will be noted that the data from the 1960 and 1970

population census were not used. The reason is that the occupational classification used in the available 10 per cent sample of the 1970 population census is unsuitable for the purposes of this specific study in that certain occupations such as mathematicians, programmers and system analysts which are regarded as natural science occupations for the purposes of this study, are not classified in such a way as to make their isolation possible.

In the classification of 19 occupational groups, natural scientists are represented by 2 occupational groups. The first group referred to as "chemists, etc." in the rest of this chapter, include the following occupational categories. The categories are quoted verbatim from the Manpower Survey No 9.

1 Chemist
2 Geologist, Geophysicist
3 Physicist
4 Mathematician, Statistician, Actuary
5 Geographer and Cartographer
6 Other scientific technologists n.e.c., e.g.Textile, Rubber, etc., Meteorologist, Hydrologist, Oceanographer, Astronomer, Anthropologist, Archaeologist.

The second group referred to as "Biologists" include:

1 Biologist, Hydrologist, Microbiologist, Algologist, Botanist, Zoologist, Physiologist

2 Agronomist, Horticulturist, Forester.

It will be noticed that programmers and systems analysts, two occupations which absorb quite a number of graduates in mathematics (see Table 2.1) are not mentioned in the above categories. The demand estimates are adjusted later in the chapter to accommodate these two occupations. Furthermore the Biologist group include agronomists which are not regarded as natural scientists for the purposes of this study. Agronomists are usually persons holding a B.Sc. (Agric.) or other specialized degree. These persons were not included in the HSRC survey (see par. 2.1). The small number of agronomists shown in Table 2.2 are in possession of B.Sc. or higher degrees but not a specialized degree. The breakdown of the labour force into 19 occupational groups was available because it was used in a study concerning the changes in the occupational structure of the labour force and the information is also utilized in this study. The Manpower Surveys of the Department of Labour do not cover the agricultural sector. The number of natural scientists employed in this sector is, however, very small as most of the

natural scientists employed in the agricultural field are employed in other sectors such as the services or manufacturing.

The occupational breakdown of the labour force by 6 sectors of industrial activity forms the basis for the estimate of the occupational structure of the labour force in 1980 from which the estimate of the demand for natural scientists is derived.

To each of the data sets, i.e. the percentages for each of the 19 occupational groups for the various years (1965, 1967, 1969 and 1971) a curve ($y = ab^{(x-x_m)} + c$) was fitted by the usual least squares method and projected to 1980. The estimates for 1980 were then either increased or decreased pro rata so that the totals of all percentages for all occupations for a specific year and sector are equal to 100.

The formula $y = ab^{(x-x_m)} + c$) was used because it gives a conservative estimate for 1980. In this case y is the percentage for an occupational group in a sector, x = 1980, x_m = 1965, 1967, 1969 and 1971 and a, b and c are parameters of the equation which change with each set of data.

The results of the extrapolation for the two occupational groups under consideration appear in Table 3.4

Application of the percentages for 1980 in Table 3.4 to the demand by sector in Table 3.3 gives estimates of the demand for natural scientists. The results are shown in Table 3.5. It must be remembered that these estimates are not estimates of actual job opportunities but estimates of the country's needs if an annual growth rate of 5,75 per cent in the GNP is to realized. It should also be kept in mind that a certain growth rate does not mean that only one single skillmix, as depicted by the occupational structure of the labour force, will have the desired results. A dam of a certain size and cost can be built in various ways and with a wide variety of labour. The same applies to the economy as a whole. A skillmix which is based on trends of the past is, however, more within the bounds of reality than one which is foreign to a labour force.

The observed percentages and estimates for male chemists etc. are portrayed in Figure 3.1. No figure was drawn for male Biologists or for female scientists as most of the percentages, for these groups when rounded to the second decimal come to 0,01 per cent.

TABLE 3.4

ESTIMATE OF THE DEMAND FOR NATURAL SCIENTISTS AS PERCENTAGE OF TOTAL LABOUR FORCE BY SECTOR

(a) Male

	Sector		1965	1967	1969	1971	1980
1	Mining	Chemists	0,255	0,343	0,425	1,067	1,559
		Biologists	0,008	0,013	0,015	0,015	0,026
2	Manufacturing and commerce	Chemists	0,378	0,359	0,604	0,317	0,472
		Biologists	0,037	0,036	0,090	0,046	0,090
3	Building and construction	Chemists	0,009	0,012	0,089	0,021	0,072
		Biologists					
4	Electricity, gas and water	Chemists	0,259	0,151	0,315	0,360	0,526
		Biologists	0,008	0,007	0,014	0,019	0,036
5	Transport and communication	Chemists	0,041	0,060	0,073	0,082	0,142
		Biologists	0,014	0,011	0,009	0,010	0,010
6	Services and finance	Chemists	0,738	0,981	0,947	0,826	0,985
		Biologists	0,581	0,517	0,468	0,536	0,536

(b) Female

1	Mining	Chemists	0,080	0,076	0,438	0,282	0,300
2	Manufacturing and commerce	Chemists	0,043	0,058	0,154	0,040	0,087
		Biologists	0,002	0,003	0,004	0,003	0,005
3	Transport and communication	Chemists		0,010	0,032	0,016	0,035
4	Electricity, gas and water	Chemists	0,953		0,630	0,340	0,340
5	Services and finance	Chemists	0,063	0,101	0,161	0,124	0,147
		Biologists	0,026	0,037	0,030	0,031	0,035

TABLE 3.5

NUMBER OF NATURAL SCIENTISTS IN 1971 AND ESTIMATED DEMAND IN 1980 BY SEX AND SECTOR

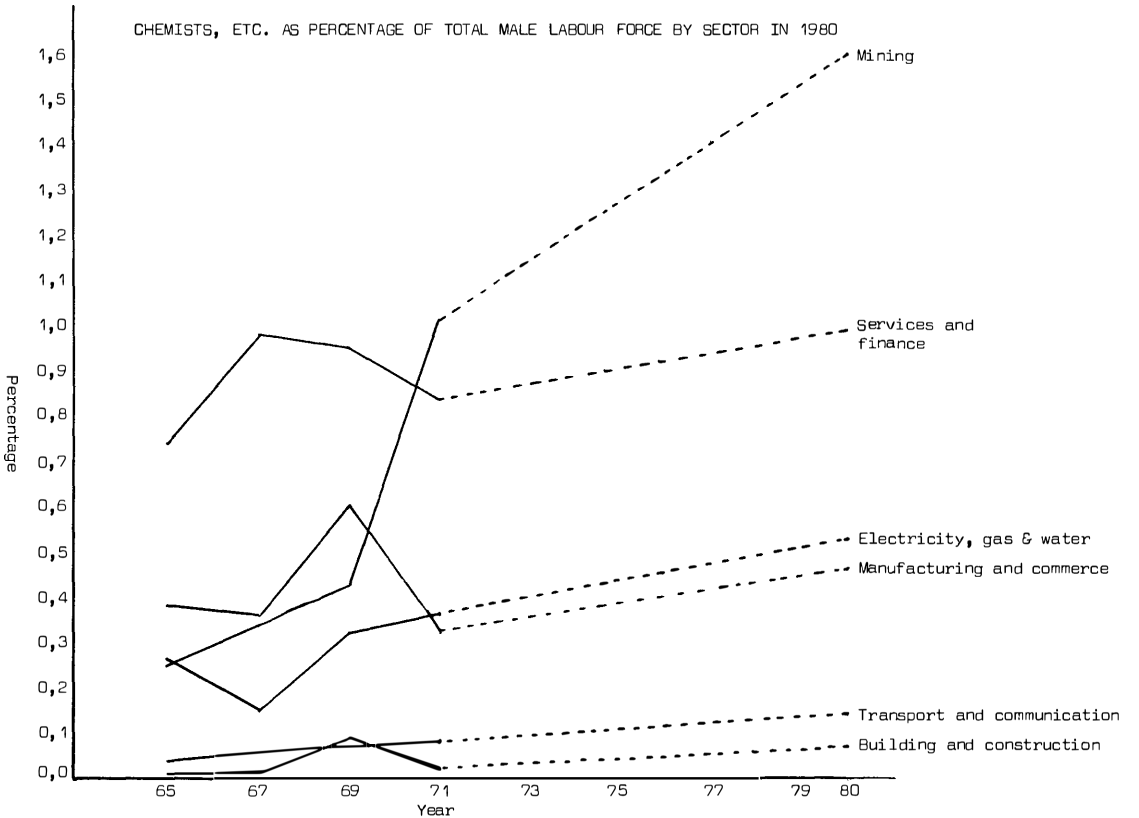
(a) Male

Sector	1 Scientist group	2 N (1971)	3 N (1980)	4 Growth rate p.a.
Mining	Chemists, etc.	638	980	6,0
	Biologists	9	15	7,4
Manufacturing and commerce	Chemists	1224	2100	8,0
	Biologists	175	400	14,3
Building and construction	Chemists	13	55	35,9
	Biologists			
Electricity, gas and water	Chemists	58	100	8,0
	Biologists	3	7	14,8
Transport and communication	Chemists	129	240	9,6
	Biologists	16	17	0,7
Services and finance	Chemists	2353	3950	7,5
	Biologists	1528	2150	4,5
TOTAL	Chemists	4415	7425	7,6
	Biologists	1731	2589	5,5

(b) Female

Mining	Chemists, etc.	13	14	0,9
	Biologists			
Manufacturing and commerce	Chemists	75	190	17,0
	Biologists	6	11	9,3
Building and construction	Chemists			
	Biologists			
Electricity, gas and water	Chemists	4	5	2,8
	Biologists			
Transport and communication	Chemists	4	10	16,7
	Biologists			
Services and finance	Chemists	273	480	8,4
	Biologists	68	115	7,7
TOTAL	Chemists	369	699	9,9
	Biologists	74	126	7,8

FIGURE 3.1


CHEMISTS, ETC. AS PERCENTAGE OF TOTAL MALE LABOUR FORCE BY SECTOR IN 1980
Percentage
1,6
1,5
1,4
1,3
1,2
1,1
1,0
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0,0
65
67
69
71
73
75
77
79
80
Year
Mining
Services and finance
Electricity, gas & water
Manufacturing and commerce
Transport and communication
Building and construction

The estimates for demand of natural scientists are based on past trends and on situations in which the supply more or less matched the demand generated. As the demand estimates are sectorized, changes in the various sectors of the economy are taken into account. The estimates are still, however, the result of a statistical manipulation which must always be evaluated before they can be accepted. The method of projecting the trends in the available data gives conservative estimates of changes in the occupational structure. On the other hand the time series available are meagre for projection purposes.

As can be seen from Table 3.5 and Figure 3.1 the percentages for men in 1971 are lower than those in 1969 in 3 of the 6 sectors. Two of these sectors, viz services and finance and manufacturing and commerce are the most important sectors as far as job opportunities for natural scientists are concerned. Whether the lower figures for 1971 are indicative of a new trend is unknown at this stage. Had it not been for a quite spectacular increase between two consecutive points in both these sectors, (for services and finance between 1965 and 1967 and for manufacturing and commerce between 1967 and 1969) the projections in both these sectors would have been much lower. On the whole, even though the figures fluctuate, a clear rising trend is obvious.

In Table 3.6 the annual projected growth rates for the period 1971-1980 (column 4, Table 3.5) are compared to the growth rates for the White labour force according to sector as calculated from the Economic Development Programme, 1972-1977.

TABLE 3.6

ANNUAL GROWTH RATES IN DEMAND FOR NATURAL SCIENTISTS (1971-1980) AND TOTAL WHITE LABOUR FORCE (1971-1977) BY SECTOR

Sector	Natural scientists				White labour force
	Chemists, etc.		Biologists		
	M	F	M	F	
Mining	6,0	0,9	7,4		1,3
Manufacturing and commerce	8,0	17,0	14,3	9,3	2,1
Building and construction	35,9				3,5
Electricity, gas and water	8,0	2,8	14,8		1,7
Transport and communication	9,6	16,7	0,7		2,1
Services and finance	7,5	8,4	4,5	7,7	3,4
TOTAL	7,2				2,6

According to Table 3.6 the estimated growth rates for natural scientists are much higher than the estimated growth rates for the total White labour force. This table also shows that the estimated growth rates for women scientists are higher than the estimates for male scientists. These higher estimates for women arise from the accumulative effect of a relative increase in the number of women scientists and the fact that the percentage of women in the total labour force is also increasing. Table 3.6 shows percentages as high as 16,7. In most cases where these very high percentages occur, the actual numbers involved are small and have little effect on the total demand estimated.

Table 3.5 shows that, in terms of job opportunities, there are only 3 important sectors for chemists, etc. namely mining; manufacturing and commerce; and services and finance. Biologists are employed mainly in the service sector. This means that the influence of relatively high growth rates for Biologists in the sectors, other than services, on the total demand estimate will be relatively small.

The growth rate for scientists in the manufacturing sector seems to be very high when compared with the estimated growth rate of the total labour force in that sector. Scientists are not employed to the same extent in the various subsectors of the manufacturing industry. Of the 1120 chemists, etc. employed in the manufacturing industry in 1971, 877 (78,3%) were employed in the manufacturing of food, beverages and tobacco, chemical products, non-metallic mineral products, basic metal products and miscellaneous products. The expected growth rates in employment in these subsectors would have an overriding effect on the employment of scientists, especially chemists, in the whole of the manufacturing industry. Other scientists are not employed in the manufacturing industry in appreciable numbers. The annual estimated growth rates (1972-1977) in employment for these subsectors according to the EOP, were as follows:

Food, beverages and tobacco	Processed foodstuffs	0,3%
	Drink and tobacco	0,2%
Chemical products	Chemical products	3,0%
	Basic chemicals	1,4%
	Mineral products	3,2%
Metal products	Basic iron and steel products	5,9%
	Non-iron metals	2,0%
	Miscellaneous manufacturing	3,5%

The estimated 8,0 per cent annual growth rate for chemists in the manufacturing industry is, therefore, much higher than any of the growth rates for the total labour forces in those subsectors which employ most of the chemists.

Table 3.7 is a calculation from a National Science Foundation publication (11) and gives the estimated growth rates in demand for 1960-1970 in the USA. This publication was prepared by the Bureau of Labor Statistics of the US Department of Labor.

TABLE 3.7

ESTIMATED ANNUAL GROWTH RATES IN THE DEMAND FOR NATURAL SCIENTISTS IN THE USA BY SECTOR FOR 1960-1970

Sector	Growth rate
Mining	1,1
Construction	9,2
Manufacturing	7,1
Transport and communications	2,5
Government services	12,1
Other services	8,3
All industries	7,2
Growth rate for total labour force	1,7

According to Table 3.7 the National Science Foundation estimated that the growth in demand for natural scientists would be very much higher than the estimated growth rate for the total labour force that is 7,2 against 1,7 which gives a ratio of 4,2 : 1. Comparable figures for the RSA (1971-1980) are 8,1 against 2,6 which gives a ratio of 3,1 : 1 which is much lower than those estimated for the USA for the period 1960-1970.

The conclusion reached by the NSF was (p.1) "Unless concerted actions are taken to increase or more effectively utilize scientific and technical manpower, shortages begun in the past decade may continue and intensify during the remainder of the 1960s ... it appears that fewer than 765 000 newly trained scientists and engineers will become available to fill more than 1 million openings for them between 1960 and 1970." A shortfall of nearly 24 per cent in the numbers trained was projected.

It is unknown what effect these estimates had on the supply of scientists in the USA but in 1972 the National Science Foundation was obviously more concerned about a surplus than a shortage. On page XV of a recent report (12) one finds: "The

unemployment rates among scientists and engineers during the second and third quarter of 1971 were 2,6 and 3,0 per cent respectively". Such a quotation is disturbing when it is kept in mind that during the latter part of the 1960s the "flow away from the sciences" was much in the news and a matter of concern in various quarters. The USA estimates of demand were obviously too high as it would have been hardly possible for training institutions to increase the output of natural scientists, who have a post-school training period of between 4-6 years, to such an extent that a shortage of the magnitude projected could be turned into a surplus. This shows that projections of demand which differ to a great extent from supply trends must be scrutinized very carefully.

The estimates of demand for the RSA must, taking the preceding discussion into consideration, be regarded as a maximum.

3.4 DEMAND FOR NATURAL SCIENTISTS BY OCCUPATION

In the preciding paragraphs natural scientists were divided into two groups. These groups are defined on page 15. The next step is to reduce these group estimates into estimates by more detailed occupations. This reduction is based on the manpower surveys Nos 7, 8 and 9 for the years 1967, 1969 and 1971. The numbers of scientists in the various occupational categories fluctuate from year to year to such an extent that in most cases there is no clear trend in the changes in the occupational structure of the natural scientists in the various sectors. The average composition of scientists by occupation and sector is therefore used for the reduction of demand by group into demand by occupation. Tables 3.8 and 3.9 show the average occupational structure of the physical and biological scientists for the period 1967-1971 respectively. By applying these percentages to the demand as estimated in Table 3.5 a more detailed occupational demand is estimated. This demand is shown in Tables 3.10 and 3.11.

Table 3.10 shows that the category "other physical scientists" is a large one, comprising 21,8 per cent in the case of men and 24,6 per cent in the case of women.

The occupational categories used in the Manpower Surveys must cover the total labour force and a detailed occupational list for natural scientists is therefore out of the question. The HSRC survey, however, gives a much more detailed list of natural science occupations and information from this survey is used to divide the group "others" into more detailed occupations. This can be done only if there is a reasonable similarity be-

TABLE 3.8

AVERAGE OCCUPATIONAL STRUCTURE OF CHEMISTS, ETC. BY SECTOR, 1967-1971

(a) Male

Occupation	Mining	Building & construction	Manufacturing & commerce	Transport & communication	Electricity, gas & water	Services & finance
Chemists	26,1	22,2	77,3	38,4	84,5	31,1
Geologists and Geophysicists	70,5	41,6	3,7			11,4
Physicists	0,5		2,3	2,5		13,3
Mathematicians & Statisticians	1,5	36,2	3,8	25,5	5,7	6,7
Cartographers and Geographers	0,4			15,6	9,8	4,8
Other physical scientists	1,0		12,9	18,0		32,7
TOTAL	100	100	100	100	100	100

(b) Female

Chemists	64,3		83,8		100,0	36,4
Geologists and Geophysicists	7,1					2,4
Physicists	7,1					8,9
Mathematicians & Statisticians	14,3		7,4			18,6
Cartographers and Geographers				66,6		2,1
Other physical scientists	7,1		8,8	33,4		31,6
TOTAL	100		100	100	100	100

TABLE 3.9

AVERAGE OCCUPATIONAL STRUCTURE OF BIOLOGICAL SCIENTISTS BY SECTOR, 1967-1971

(a) Male

Occupation	Mining	Building & construction	Manufacturing & commerce	Transport & communication	Electricity, gas & water	Services & finance
Biologists	22,7		32,2			29,3
Agronomists	77,3		67,8	100,0	100,0	70,7
TOTAL	100		100	100	100	100
(b) Female						
Biologists			100,0			89,3
Agronomists						10,7
TOTAL			100			100

TABLE 3.10

DEMAND ESTIMATES FOR CHEMISTS, ETC. BY OCCUPATION

(a) Male

Occupation	Mining	Building & construction	Manufacturing & commerce	Transport & communication	Electricity, gas & water	Services & finance	Total N	Total %
Chemists (C)	255	12	1623	93	85	1228	3296	44,4
Geologists & Geophysicists (E)	690	23	77			452	1242	16,7
Physicists (P)	5		49	6		525	585	7,9
Mathematicians & Statisticians (M)	15	20	80	61	6	265	447	6,0
Cartographers & Geographers	5			37	9	190	241	3,2
Other physical scientists	10		271	43		1290	1614	21,8
TOTAL	980	55	2100	240	100	3950	7425	100
(b) Female								
Chemists (C)	9		160		5	175	349	49,9
Geologists & Geophysicists (E)	1					12	13	1,9
Physicists (P)	1					43	44	6,3
Mathematicians & Statisticians (M)	2		14			89	105	15,0
Cartographers & Geographers				6		10	16	2,3
Other physical scientists	1		16	4		151	172	24,6
TOTAL	14		190	10	5	480	699	100

TABLE 3.11

DEMAND ESTIMATES FOR BIOLOGICAL SCIENTISTS BY OCCUPATION

(a) Male

Occupation	Mining	Building & construction	Manufacturing & commerce	Transport & communication	Electricity, gas & water	Services & finance	Toral N	Toral %
Biologists	3		129			630	762	29,4
Agronomists	12		271	17	7	1520	1827	70,6
TOTAL	15		400	17	7	2150	2589	100
(b) Female								
Biologists			11			103	114	90,5
Agronomists						12	12	9,5
TOTAL			11			115	126	100

tween Manpower Survey No 9 of 1971 and the HSRC survey. In Table 3.12 these two surveys are compared. The number of chemists in the manpower survey were reduced because all the persons taking part in the HSRC survey were graduates while the Manpower Survey states no educational level at all. The reduction was based on the proportion non-graduate chemists in the various sectors according to the 1970 population census, which shows that 10,6 of the chemists in mining, 21,1 per cent in manufacturing, 40 per cent in commerce and 1,8 per cent in services were non-graduates.

TABLE 3.12

OCCUPATIONAL STRUCTURE OF NATURAL SCIENTISTS ACCORDING TO MANPOWER SURVEY NO 9 AND 1971 HSRC SURVEY

Occupation	Manpower survey				HSRC survey			
	Men		Women		Men		Women	
	N	%	N	%	N	%	N	%
Chemist	1640	36,1	130	31,3	465	30,0	62	25,5
Geclogist and Gecphysicist	738	16,2	9	2,2	270	17,4	10	4,1
Physicist	291	6,4	11	2,7	133	8,6	6	2,5
Biologist, Hydrobiologist, Microbiologist, Algolist, Botanist, Zoologist, Physiologist,	614	13,5	67	16,1	234	15,1	86	35,4
Mathematician, Statistician, Actuary	326	7,2	48	11,6	141	9,1	23	9,5
Others	938	20,6	150	36,1	305	19,7	56	23,0
TOTAL	4547	100	415	100	1548	100	243	100

Taking into consideration that the Manpower Survey is a sample survey of employers and the HSRC survey a survey of individuals, one should perhaps be satisfied with the amount of agreement between the two surveys as shown in Table 3.12.

Some large differences do occur especially in the categories for women biologists, where the HSRC survey shows a percentage of 35,4 against the 16,1 per cent of the Manpower Survey, and for male chemists where the percentages are 30,0 and 36,1 respectively. The male/female ratio is also markedly different. The Manpower Survey shows a ratio of 11 to 1 and the HSRC survey a ratio of 6 to 1. The reasons for these differences are difficult to pinpoint. Individuals are apt to upgrade occupa=

tions when they supply occupational information. On the other hand, the HSRC survey deals with graduates only while the Manpower Survey does not specify any kind of educational level.

The general agreement is such, however, that the HSRC survey's occupational structure can be used for the occupational classification of the scientists in the "other scientific technologists" group.

Occupations not specifically mentioned in the Manpower Survey are regarded as "others" in this case.

The structure of this group according to the HSRC survey is shown in Table 3.13 cclumns 1 and 3 for men and women respectively.

TABLE 3.13

OCCUPATIONAL STRUCTURE OF "OTHER SCIENTIFIC TECHNOLOGISTS" ACCORDING TO HSRC SURVEY BY SEX AND DEMAND ESTIMATES FOR 1980

Occupation	1 Male	2 Demand	3 Female	4 Demand
	%	1980	%	1980
Mineralogist (E)	2,2	35		
Geochemist (E)	1,6	25	1,8	3
Biochemist (B)	13,4	216	36,4	64
Entomologist (B)	14,6	235	12,7	22
Soil Scientist (B)	3,1	50		
Oceanographer (B)	5,6	90		
Plant Pathologist (B)	5,0	81	1,8	3
Plant Geneticist (B)	4,0	65		
Food Technologist (B)	5,6	90		
Biometrist (B)	1,6	25	3,6	6
Nature Conservationist (B)	1,6	25	1,8	3
Other biological (B)	13,4	216	27,3	47
Spectrochemist (C)	0,6	10		
Chemical Technologist (C)	9,7	157		
Other chemist (C)	3,1	50	5,5	9
Meteorologist (P)	4,7	74	5,5	9
Spectrographist (P)	0,6	10	1,8	3
Actuarial Clerk (M)	9,3	150	1,8	3
Astronomer (M)	0,3	10		
TOTAL	100	1614	100	172

The numbers in columns 2 and 4 are the result of the application of the percentages in columns 1 and 3 to the numbers in the group "other scientific technologists" as shown in Table 3.10.

It is now possible to categorize the estimated demand into the 5 major scientist groups used in the HSRC survey, namely the

(a) biology group,
(b) chemistry group,
(c) earth science group,
(d) mathematics group, and
(e) physics group.

These groups are marked B, C, E, M and P in Tables 3.10, 3.11 and 3.13. Before estimating the final demand by the 5 groups certain adjustments to the data from which this demand is derived, viz that in before-mentioned tables, have to be made.

(a) The mathematics group (M) in Table 3.10 must be increased to accommodate the graduate programmers, data processors and systems analysts (see par. 3.3). Not all the programmers, etc. are graduates and no information is available to determine what proportion of those persons working in these occupations are graduates. It is not even sure how many persons are working as computer programmers and systems analysts. The Manpower Surveys listed this occupational category in 1969 for the first time and the survey for 1969 showed 310 men employed in this occupational category. In 1971 this figure had risen to 673. It must be assumed that some employers also classify personnel responsible for work programmes or work flows in this category. Quite a number of systems analysts have an engineering background and engineers are not included in this survey. It is unknown what the training background of the systems analysts are.

The demand for the mathematics group is adjusted to include graduate programmers, systems analysts and data processors by assuming that the ratio between these occupations and the mathematicians, statisticians and actuaries will be as it was shown in the HSRC survey (Table 2.2). Table 2.2 shows this ratio for men to be 163 programmers, etc. to 141 mathematicians, statisticians and actuaries. For women the figures are 73 to 23. The demand for mathematicians which include only mathematicians, statisticians and actuaries is now increased by using these ratios. The demand in Table 3.10 is, therefore, increased to 964 and 438 work opportunities for male and female mathematicians annually. The group M henceforth includes programmers, etc.

(b) The group cartographers and geographers (241 men and 16 women in Table 3.10) is not included in the final demand estimate, because in the HSRC survey only 1 graduate supplied

his occupation as geographer and none of the survey group supplied the occupation of cartographer. It is therefore assumed that these occupations do not attract graduates to an extent worth mentioning. Graduates in geography seem to choose other occupations.

(c) Also not included are the 1827 male and 12 female agronomists in Table 3.11. For the purposes of this study agronomists are not regarded as natural scientists (see par. 3.2). This group was carried along because it was included in the available breakdown of the total labour force into 19 occupational groups (see par. 3.3).

The final demand estimates shown in Table 3.14 are derived at by adding the categories marked B, C, E, M and P in Table 3.13 to the corresponding categories in Tables 3.10 and 3.11. The adjusted figure for the M group must in this case be kept in mind (see (a) above).

Table 3.14 also shows the supply (number of filled posts) in 1971. The supply figure for mathematicians is adjusted in the same way as explained in (a) above, namely from 326 and 48 to 797 and 203 for men and women respectively.

The total annual growth rate shown in Table 3.14 differs slightly from that in Table 3.6. This difference is owing to the adjustment made from programmers and systems analysts as well as the deletion of agronomists, geographers and cartographers.

In the next chapter the implications for training of the demand estimates as presented will be discussed.

TABLE 3.14

ESTIMATED SUPPLY OF NATURAL SCIENTISTS IN 1971 AND ESTIMATED DEMAND IN 1980 BY MAJOR SCIENTIST GROUP

Scientist group	Supply 1971		Demand 1980		Annual increase in requirements		Annual growth rate	
	M	F	M	F	M	F	M	F
Biology	1314	195	1855	259	60	7	4,6	3,6
Chemistry	2026	152	3513	358	165	23	8,1	15,1
Earth Science	838	12	1302	16	51	1	6,1	3,7
Mathematics	797	203	1124	441	36	26	4,6	13,0
Physics	343	22	669	56	31	4	8,2	17,2
TOTAL	5318	584	8463	1130	343	61	6,6 (6,9)	10,4

CHAPTER 4

IMPLICATIONS OF THE ESTIMATED DEMAND FOR TRAINING

Table 3.14 shows the annual growth in requirements to be just over 400 natural scientists of both sexes for the period 1971-1980. In addition to the 400 scientists quite a number will be needed annually to replace current members of these occupations who will retire, die or transfer to other occupations. It is a reasonably simple task to calculate replacement needs on account of retirement and death when the age structure of a population is known by making use of activity and death rates. Transfers to other occupations are quite another matter. How complicated this can be is illustrated in Table 4.1 where the occupational flow for male chemists for the period 1968-1971 is shown. Data for this table were tabulated from the National Register of Natural and Social Scientists. During 1968 there were 481 men who listed their occupation as that of chemist and who again took part in the 1971 survey. Of these 481 only 289 (60,1%) again stated their occupations as chemist. During this time an outflow of 192 occurred. Table 4.1 shows what happened to these 192 persons (column 1). During the same time there were 202 persons who indicated their occupations as chemists in 1971 having declared another occupation in 1968. These represent an inflow into the occupation (column 2).

TABLE 4.1

INFLOW AND OUTFLOW OF MEN FOR THE OCCUPATION OF CHEMIST, 1968-1971, NEW GRADUATES EXCLUDED

Occupation	Outflow : Occupation in 1971 1	Inflow Occupation in 1968 2	Gain of chemist occupation 3
Administrative occupations	71	24	-47
Pharmacists	5	7	2
Biochemists	9	6	-3
Physicists	9		-9
Geologists, Minerologists	4	2	-2
Engineers	14	2	-12
Metallurgists	12	1	-11
Lecturers, Teachers	14	25	11
Other scientists	8	55	47
Other occupations	34	38	4
Post-graduate students	9	39	30
Looking for work	1	3	2
Retired	2		-2
TOTAL	192	202	10

Table 4.1 shows that a net inflow of chemists occurred during the period 1968-1971. This net inflow was however very small. The table shows that chemists are leaving the occupation to fill administrative posts, which is of course a natural thing to happen.

Quite a number of chemists also became engineers (net loss 12) and metallurgists (net loss 11). The occupation attracted 55 persons from related scientific occupations while only 8 left the occupation of chemist to become some other kind of scientist. The inflow and outflow to other occupations is about the same (38 against 34).

The table shows how very complicated occupational flow is. To calculate flow tables for the various science occupations in this report is at the moment not feasible because the necessary information is not available, but it is a factor of such magnitude that it must be taken into consideration.

Table 2.1 (Chapter 2) gives the occupational structure of the HSRC survey group. This table shows that of the 5006 men and 1704 women in the survey group, only 1753 men and 325 women were actively engaged in those occupational groups regarded, for the purposes of this study, as natural science occupations. The large number of occupations in this table is reflected in Table 4.1 and the situation depicted in Table 2.1 can be regarded as the crystallization at a given point of time of a situation that has developed over quite a number of years. The occupational structure as shown in the table is the result of the interaction between the demand for and supply of manpower for the various occupations. This structure will change over time as the relative demand and supply situation changes. It is obvious from Table 4.1 that training and experience result in substitution possibilities. It can, therefore, be expected that occupations in which a tight supply situation, together with high income possibilities, are experienced will draw personnel from related occupations in which the income possibilities are perhaps not so good.

This interoccupational flow seldom results in a very great loss for a specific occupation, so that it can be expected that the occupational structure of natural science graduates, as shown in Table 2.1, will most likely not change dramatically over the next few years. This structure is therefore used to estimate the number of persons who will have to be trained in the natural science field to ascertain that 343 men and 61 women will be available for employment in one of the natural science occupations, annually. Assuming this structure as the basis for

inflating the number to be trained means that it is also assumed that the demand in occupations which attract natural science graduates will increase at the same rate as the demand for natural scientists.

Table 2.1 shows that of the 5006 male and 1704 female natural science graduates 1753 (35,0%) men and 325 (19,1%) women are actively engaged in the 5 natural science occupations.

It is therefore estimated that 979 men and 319 women must be trained annually to ensure that 343 men and 61 women will be available annually for natural science occupations. It must be kept in mind that it is not foreseen that the 979 newly trained men or 319 women will practise the occupations as shown in Table 2.1. The occupational structure of the newly trained will be totally different from that shown in Table 2.1. It can, for example, hardly be expected that 14,6 per cent will occupy managerial posistions or that 12,8 per cent will become lecturers or professors. They are, however, replacements for more experienced scientists moving to managerial positions or into the teaching field. This inflated figure, however, provides for 16,4 per cent of the newly trained to become natural science teachers.

It also provides for movement to the other occupations with a natural science major as well as for retirement, movement out of the labour force, etc.

Replacement needs which result because of deaths are not taken into account. It was mentioned in the introduction that a number of the accountants and some of those practising legal professions and other non-natural science occupations such as psychologists, were included in the survey as one of the majors for their degrees was mathematics or mathematical statistics. These persons usually do not receive a B.Sc. degree, but a B.A. or B.Com. with these subjects as majors, and replacements are related to persons receiving B.Sc. degrees. By not deflating the figure of numbers to be trained because of these occupations, the effect of death is cancelled to an unknown extent.

Another factor which will influence the supply will be the net gain in natural scientists owing to immigration. Table 4.2 shows the net gain in natural scientists owing to this factor for the period 1968-1971. The data were supplied by the Department of Statistics.

TABLE 4.2

NET GAIN IN NATURAL SCIENTISTS OWING TO IMMIGRATION, 1968-1971

Occupation	1968		1969		1970		1971	
	M	F	M	F	M	F	M	F
Chemists	39	1	61	3	68	5	25	12
Physicists	8		8	1	11	2	7	
Geologists	24	1	40	1	62	4	52	
Other physical scientists	8	1	19	4	18		7	
Biologists			13	4	12	1	10	2
TOTAL	79	3	141	13	171	12	101	14

It is known that the immigration rate to the RSA has de= creased in the last few years. In 1970 the RSA received 41 523, in 1971, 35 845 and in 1972, 32 776 immigrants. The available figures for 1973 show the same declining trend: for the period January to March 1971 9505 new immigrants arrived in the RSA against the 6155 for the same period in 1973. The emigration rate is, however, also going down. It is very difficult to make estimates of immigration rates, but it seems urlikely that, should those factors which influence immigration remain fairly constant, that the net annual immigration gain will be less than half the average for the period 1968-1971. Assuming this to be the case the number of natural scientists will be increased by 60 men and 5 women per annum over the period 1972-1980. It is therefore estimated that it will be necessary to train 920 men and 315 women annually from 1972 to 1980 to meet the estimated demand for natural scientists in 1980.

CHAPTER 5

ESTIMATE OF THE SUPPLY OF NATURAL SCIENTISTS

An estimate of the number of B.Sc. graduates produced by the universities in the RSA will be a close approximation of the number of natural scientists available to the national economy, because in the educational system of the RSA most of the natural scientists receive a B.Sc. as first degree. The supply of natural scientists is, therefore, estimated in terms of the number of B.Sc. graduates produced by the universities. The information pertaining to the number of degrees conferred are compiled by the Institute of Statistical Research of the HSRC.

Table 5.1 gives by sex the number of B.Sc. degrees conferred from 1960 to 1972. This time series is the basis for the projections of the future supply. Table 5.1 shows that while a reasonable rising trend in the number of degrees conferred on men is noticeable for the period 1960-1968, a new and sharply declining trend for the years after 1968 is experienced. In the case of women a steadily rising trend is noticeable throughout the time series.

TABLE 5.1

NUMBER OF B.Sc. DEGREES CONFERRED BY SOUTH AFRICAN UNIVERSITIES FOR THE PERIOD 1960-1972

Year	Male	Female
1960	447	162
1961	519	180
1962	550	176
1963	524	203
1964	483	212
1965	513	256
1966	481	255
1967	536	269
1968	644	296
1969	585	309
1970	543	328
1971	501	342
1972	471	348

In Table 5.2 various projections, all based on the time series are presented. The time series as well as projections are portrayed in Figure 5.1 for men and Figure 5.2 for women.

TABLE 5.2

PROJECTION OF THE NUMBER OF B.Sc. DEGREES THAT WILL BE CONFERRED BY SOUTH AFRICAN UNIVERSITIES, 1973-1980

Year	Male			Female	
	1	2	3	4	5
	Rectilinear on 1960-1972	Rectilinear on 1968-1972	Exponential on 1968-1972	Rectilinear on 1960-1972	Exponential on 1968-1972
1972	471	471	471	348	348
1973	544	420	445	373	360
1974	547	377	430	390	365
1975	550	334	420	407	370
1976	553	291	410	423	375
1977	556	248	405	440	380
1978	559	205	403	457	385
1979	562	162	403	473	388
1980	565	118	403	490	390
Average for period 1972-1980	545	290	420	420	375

In the case of men, column 1 of Table 5.2, is a rectilinear projection of the whole time series, column 2 is a rectilinear projection of the trend 1968-1972 and column 3 is an exponential projection of the trend 1968-1972. For women two projections are presented. Column 4 is a rectilinear and column 5 an exponential projection of the whole time series. The table and figures show the problems experienced when trend extrapolations are used to estimate future developments. The results of the various extrapolations differ greatly.

In the case of men the rectilinear projection based on the whole time series can be dismissed out of hand because of the clear indication of a new trend for the period 1968-1972.

It remains now to choose between the rectilinear and exponential projections for the period 1968-1972, both of which are based on lines of very good fit. In the case of women both the projections presented are also based on lines of very good fit.

To help in the decision, information on the number of White students enrolled for the first year in South African Universities was compiled from the yearly reports of the Departments of National Education. Only students enrolled in the faculties of mathematics and general science are considered. Students enrolled for specialized science courses are excluded and because information for UNISA is not available throughout, the students of this university are also left out of consideration. Table 5.3 shows the enrollment for 1963 to 1971.

TABLE 5.3

NUMBER OF FIRST YEAR WHITE STUDENTS ENROLLED IN SOUTH AFRICAN UNIVERSITIES (EXCLUDING STUDENTS OF UNISA) IN THE FACULTIES OF MATHEMATICS AND NATURAL SCIENCE (EXCLUDING STUDENTS IN SPECIALIZED COURSES) AS ON THE SECOND WEEK OF JUNE

	1963	1964	1965	1966	1967	1968	1969	1970	1971
Men	1215	1062	1292	1396	1225	1452	1282	1194	1222
Women	437	514	523	567	591	660	635	623	635

According to Table 5.3 the numbers of male first year students fluctuated from year to year although a slight rising trend, peaking in 1968, is noticeable. The numbers decreased in 1969 and 1970 but in 1971 more students enrolled than in 1970. Should the number of enrolments remain in the order shown for 1971, it can be expected that the declining trend in number of degrees conferred on men will indeed level out. The exponential projection of number of degrees conferred is, therefore, chosen in the case of men. Table 5.3 shows that the number of women students enrolled, also peaked in 1968. In 1969-1971 the number decreased slightly but remained fairly constant for this period. This situation leads one to choose the exponential extrapolation in the case of women too.

On the basis of these projections the average production of men with a B.Sc. as first degree is estimated at 420 and that of women at 375 per annum, which gives a total production of nearly 800 B.Sc. degrees annually over the projection period.

FIGURE 5.1

EXTRAPOLATION OF TRENDS IN NUMBER OF B.Sc. DEGREES CONFERRED ON MEN

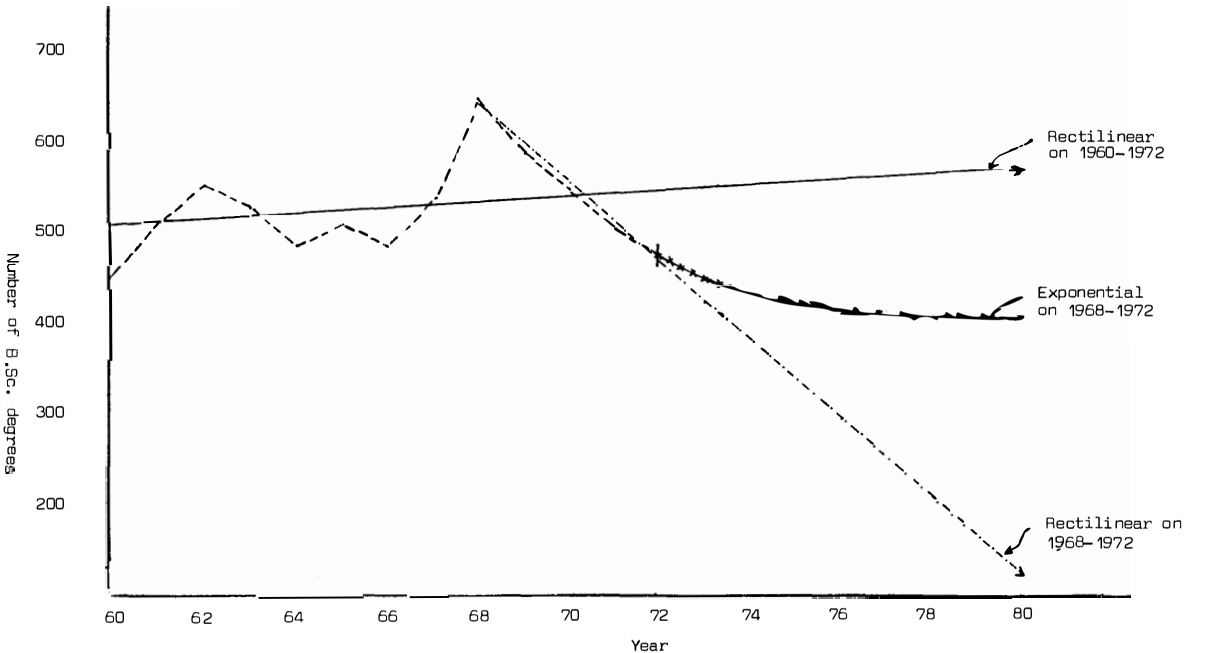
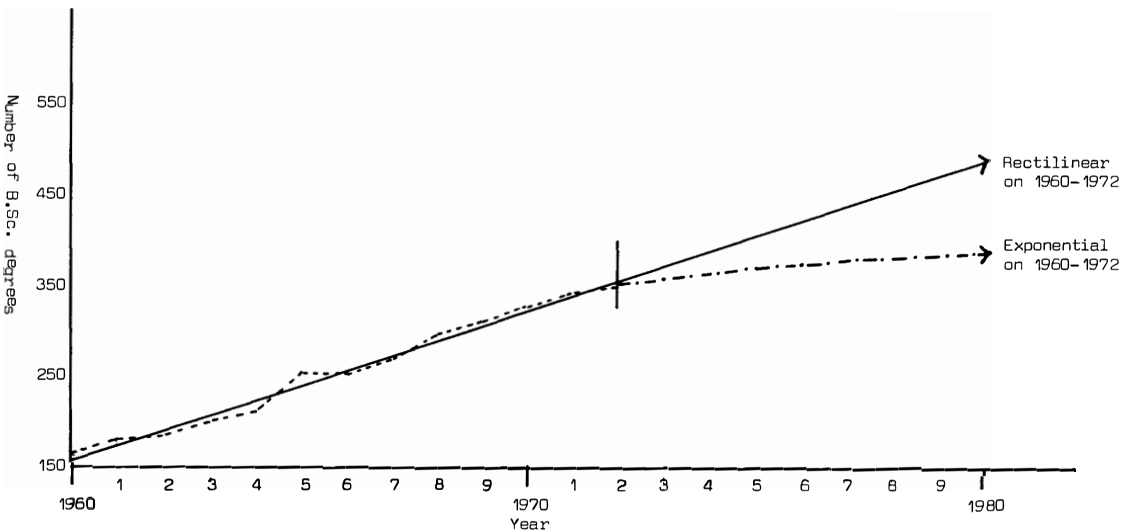


FIGURE 5.2

EXTRAPOLATION OF TRENDS IN NUMBER OF B.Sc. DEGREES CONFERRED ON WOMEN



CHAPTER 6

DEMAND AND SUPPLY COMPARED

In Table 6.1 the final demand and supply estimates are compared.

TABLE 6.1

ANNUAL AVERAGE DEMAND AND SUPPLY OF B.Sc. GRADUATES, 1972-1980, BY SEX

	Demand 1	Supply 2	Difference 1-2	Percentage shortage
Male	920	420	500	54,3
Female	315	375	-60	-19,0
TOTAL	1235	795	440	35,3

As was stated in the introduction it is the aim of this report to estimate the country's needs under a certain set of assumptions. Table 6.1 shows that these assumptions result in the projection of a large annual shortage (54,3%) of male natural science graduates. On the other hand Table 6.1 indicates a surplus of female graduates to the order of 19 per cent of the annual demand.

The results of these estimates must however be approached with the necessary caution. It is perhaps at this stage necessary to stipulate the major assumptions on which the demand and supply estimates are based and which directly influence the demand and supply projections for the period 1972-1980.

(a) The demand for natural scientists will increase at an annual rate of 6,6 per cent for men and 10,4 per cent for women (Table 3.14).

(b) The occupational structure of natural science graduates will remain constant (Chapter 4).

(c) The average annual production of B.Sc. graduates will be 420 for men and 375 for women (Table 5.2).

Having a more or less fixed set of assumptions for the projection period means that changes that do occur during that period cannot be taken into account. It must be kept in mind, however, that the interaction between supply and demand will continue throughout the projection period. The inflated figure of demand rests on the assumption that the interoccupational flow which was the result of a certain demand supply ratio in

the past will remain constant over the projection period. It is reasonable to expect that the interoccupational flow will be influenced if the demand supply ratio is changed drastically as is projected by this study. The projected oversupply of women does not mean that women graduates will be without work. Given the projected shortage of men, it would be reasonable to expect that employers will be pushed to employ women to an even greater extent than before. These substitution possibilities are, however, limited. Women have not only a special pattern of labour force participation, but do not continue their studies to post-degree level in nearly the same proportion as men do.

The teaching field, being popular with women, is perhaps the field in which most of the substituion will occur and male natural science teachers may become even scarcer in the future. An increased flow into natural science occupations could be expected from male teachers but this flow will be restricted because most of the natural science teachers teach with a first degree. It is, however, improbable that the direction of the flow will be reversed and that persons who left the natural science field shall return. The magnitude may be affected though, so that the loss to other occupations becomes less. This will happen if the relative salary differentials are affected by an increasing shortage over time. Should the present salary differentials remain, occupational flows will be less affected.

Another factor which will have an effect on the magnitude of the occupational flow will be the rate of increase in demand for the other occupations. Should this rate be lower than that which is projected for natural scientists, there will be less opportunity for natural science graduates to move into other occupations.

One supply source has been left out of consideration and that is the number of South African residents who receive their training overseas and then return to the RSA. This aspect will have little effect on the number of first degree graduates available.

It is not possible to quantify the effect of the factors mentioned above on the demand for natural scientists, but it is clear that, should the declining trend in supply and rising trend in demand continue, the existing shortages will continue and intensify. That present trends cannot continue is evident, and it is unlikely that deficits of the magnitude indicated will be observable by 1980. Accommodations to the existing manpower situation will occur and adjustments will be made by employers. Some of these adjustments will lead to better utilization of the available manpower and in such cases shortages are not a bad

thing. On the other hand it must be remembered that the cost of shortages, in terms of lost possible benefits, is not easily calculated in the natural science field. How can one calculate the benefits that may have arisen from projects that had to be postponed, cancelled or carried out less efficiently because of shortages in qualified manpower? If the declining trend is also accompanied by a more than proportional decline in innate ability of the student material, the situation will be aggravated. With the rising popularity of the professional fields of study such as medicine, dentistry, law and engineering, such a possibility must be faced. No factual information about this aspect is however available.

The estimated shortages in the case of men are, of such a magnitude that the demand projection cannot be set as a realistic target for training purposes. The supply in this study has been estimated at about 400 male graduates per annum for the projection period. Making an about turn, it can now be asked: What growth rate in demand for male natural scientists would a production of 400 degrees per annum allow for?

Assuming that the occupational structure used to inflate the demand for natural scientists will remain constant, about 140 of the graduates will be available for growth, the rest going for replacement needs of various sorts. Assuming a net annual gain of 60 immigrants the number available for growth is 200 per annum. Table 3.14 gives the supply as 5318 in 1971 and if 200 are available for growth the annual growth rate is 3,8 per cent. This is 1,2 per cent higher than the growth rate of 2,6 per cent for the total White labour force (see Table 3.6). An increase of 3,8 per cent in the demand for male natural scientists would be relatively higher and, therefore, in line with the general rising trend in demand although much lower than the projected demand growth rate of 6,6 per cent.

Taking the sharp decline in the production of male B.Sc.s for 1969-1972 into consideration, it would perhaps be more realistic to aim for a production of about 400-450 male B.Sc.s per annum.

The discussion up to now has centred on the number of B.Sc. graduates demanded and produced. It has been shown in Table 2.7 that the various scientist groups are highly qualified. Taking the qualification structure into consideration it can perhaps be stated that, speaking in general terms, a person with a B.Sc. degree can hardly be regarded as a qualified scientist. This is especially true for those scientists whose main function is research and development.

The numbers of Hons.degrees would give an indication of the supply of natural scientists available for more advanced work. Table 6.2 shows the number of B.Hons. degrees conferred by South African universities for the period 1968-1972.

TABLE 6.2

NUMBER OF B.Sc. HONS. DEGREES CONFERRED BY SOUTH AFRICAN UNIVERSITIES,1968-1972

Year	Male	Female
1968	214	56
1969	246	63
1970	258	68
1971	251	97
1972	250	94

Since 1968 the number of Hons. degrees for men have remained fairly constant at about 150 p.a. The numbers conferred on women show a reasonable rising trend.

Table 2.7 shows (bottom row) the percentage of scientists in each of the groups who have an Hons. degree or higher qualification. Taking these percentages as basis it is estimated that the demand as estimated in Table 3.14 will entail an annual production of about 200 Hons. degrees for men and 10 for women. Comparing these figures to the actual production figures Table 6.2 show the production to be such that a certain number of replacement needs can be met. It must be kept in mind that the demand estimates of Table 3.14 are regarded as a maximum.

The sharply declining trend in the B. degrees is not noticeable in the numbers of Hons. degrees. It must be remembered that there is a certain time lag here and it could be expected that the numbers of Hons. degrees would also decline in the future.

It is quite possible that a situation develops in which the total number of B.Sc. graduates produced by universities are enough to meet the total demand for natural scientists, but that the field of study of the graduates is such that shortages in some fields of study can occur while surpluses are experienced in some other field.

Table 6.3 shows the major subject structure of the groups of natural scientists of the HSRC survey.

TABLE 6.3

MAJOR SUBJECT STRUCTURE OF 5 NATURAL SCIENTIST GROUPS

Major subject	Biology group		Chemistry group		Earth science group		Mathematics group		Physics group	
	N	%	N	%	N	%	N	%	N	%
Chemistry	118	13,0	497	51,0	110	22,4	55	8,5	32	10,3
Botany	213	23,4	22	2,3	4	0,8				
Geology	27	3,0	62	6,4	213	43,5	7	1,1	2	0,6
Geography	23	2,5	9	0,9	53	10,8			1	0,3
Physics	30	3,3	159	16,3	44	9,0	76	11,7	126	40,5
Mathematics	23	2,5	135	13,8	23	4,7	251	38,6	112	36,0
Applied Maths.	6	0,7	14	1,4	6	1,2	60	9,2	32	10,3
Statistics and Math. Statistics			10	1,0			159	24,5		
Zoology	265	29,1	25	2,6	7	1,4				
Physiology	38	4,2	15	1,5						
Entomology	79	8,7								
Mineralogy & Geology					18	3,7				
Others	88	9,7	27	2,8	12	2,4	42	6,5	6	1,9
TOTAL	910	100	975	100	490	100	650	100	311	100

Assuming that the structure as shown in Table 6.3 for the various scientist groups is an adequate study background for the work they do, this structure is applied to the annual increase in work opportunities as estimated in Table 3.14. Requirements for men and women are summed up in this case and it is assumed that every graduate has 2 major subjects.

Table 6.4 shows that 3 fields of study play a very important role in the skillmix of natural scientists namely Chemistry, Physics and Mathematics. When Applied Mathematics and Statistics and Mathematical Statistics are added to the above three, Table 6.4 shows that more than two-thirds of all major subjects taken for a first degree must be one of those mentioned. The structure as shown in Table 6.4 is of course directly influenced by the demand projections (see Table 3.6).

Information on the major subject structure of the supply is not readily available. The Joint Council of Scientific Societies (JCSS) conducted a survey in which information about the number of students who completed a first degree and the major subjects taken, was asked from the various universities. Information for the years 1960-1969 was gathered. This information supplied by the JCSS, is not strictly comparable to the demand as estimated in Table 6.4 because the information of the JCSS has bearing on first degrees and not only on B.Sc. degrees as such. Specialized degrees such as B.Sc. (Pharm.) were therefore included; for example the University of Potchefstroom conferred 79 B.Sc. degrees in 1969 while stating that 100 students completed a first degree with chemistry as major subject in 1969. Comparison of the JCSS data with the major subject demand estimates gives some idea of possible unbalances that could develop. The comparison for the most important major subjects is found in Table 6.5. The demand figures in this table are not inflated.

The comparison between major subject structure of the uninflated demand and the supply in Table 6.5 is in some sense spurious, because the demands of those occupations which absorb natural science graduates will have a direct influence on the ideal major subject structure of production. It is known for example that mathematics and statistics have a wide field of application so that it cannot be reasoned that too many students take mathematics or statistics as major subjects.

The table, however, indicates that too many students may be taking zoology as a major while chemistry and physics are in short supply. The increasing number of women B.Sc. graduates may be responsible for a certain amount of the disparagement between the structures of supply and demand. It has been shown in

TABLE 6.4

MAJOR SUBJECT STRUCTURE OF ANNUAL REQUIREMENTS FOR 1972-1980

Major subject	Biology group	Chemistry group	Earth science group	Mathematics group	Physics group	Total N	Total %
Chemistry	17	191	23	11	7	249	30,8
Botany	31	9	1			41	5,1
Geology	4	24	45	1		74	9,2
Geography	3	3	11			17	2,1
Physics	4	61	9	15	29	118	14,6
Mathematics	4	52	5	48	25	134	16,6
Applied Mathematics	1	5	1	11	8	26	3,2
Statistics & Math. Statistics		4		30		34	4,2
Zoology	39	10	2			51	6,3
Physiology	6	6				12	1,5
Entomology	12					12	1,5
Others	13	11	7	8	1	40	5,0
TOTAL	134	376	104	124	70	808	100

the HSRC report on Biologists (5) that relative more women than men tend to choose some field of biology as field of study. As the number of male B.Sc. graduates decline and the number of women increase, a shift towards the biological sciences may result. Such a shift would not be in concurrence with the demand for natural scientists as the expected growth in demand for example Chemists, Geologists, and Physicists are greater than that for Biologists.

TABLE 6.5

MAJOR SUBJECT STRUCTURE OF ANNUAL UNINFLATED DEMAND (1972-1980) AND AVERAGE ANNUAL NUMBER OF MAJOR SUBJECTS PRODUCED BY UNIVERSITIES 1967-1969

Major subject	Uninflated demand		Produced	
	N	%	N	%
Chemistry	249	34,3	285	22,8
Physics	118	16,2	132	10,5
Zoology	51	7,0	178	14,2
Botany	41	5,6	107	8,5
Geology	74	10,2	87	7,0
Mathematics	134	18,4	269	21,5
Applied Mathematics	26	3,6	86	6,9
Statistics & Mathematical Statistics	34	4,7	108	8,6
TOTAL	727	100	1252	100

The indication is, therefore, that the shift in the male : female ratio will also adversely affect the supply of scientists such as Chemists, Geologists and Physicists.

The conclusion reached is that it is quite possible that serious shortages in natural scientists could be experienced in the future if the expected growth rate in the economic development of the RSA results in the demand for manpower as estimated by the EDP. This shortage will be mostly felt in the physical science field such as geology, chemistry and physics. It could also be expected that the supply of male science teachers will be limited and that the male : female ratio of science teachers will continue to change in favour of the women.

CHAPTER 7

SYNOPSIS AND CONCLUSION

The aim of this study is to examine the demand and supply situation of natural scientists in the RSA for the period 1972-1980. The estimates presented in this report are projections of the country's needs under a certain set of assumptions rather than a projection of actual employment.

The basic information for this study was obtained from the Manpower Surveys of the Department of Labour for 1965, 1967, 1969 and 1971, the HSRC survey of natural scientists in 1971, the population census of 1960 and 1970 as well as estimates of the demand for labour as supplied by the Division for Economic Planning of the Department of Planning.

Natural scientists are divided into 5 groups, viz the

Biology group
Chemistry group,
Earth science group,
Mathematics group and
Physics group.

Based on the changes in the occupational structure of the labour force experienced during the period 1965-1971, an estimate was made of the percentage natural scientists in the total White labour force in 1980. Using EDPs demand for labour as basis and the HSRC survey to fill certain gaps in the information, the demand by the scientist group in 1980 was estimated. The detailed estimate is supplied in Table 3.14 by group and sex.

The supply of natural scientists is estimated at 5318 men and 584 women in 1971 while the demand in 1980 is estimated at 8463 work opportunities for men and 1130 for women. These estimates imply an annual growth rate in requirements of 6,6 and 10,4 for men and women respectively. These growth rates are regarded as the maximum which the demand for natural scientists can reach. To satisfy this demand it is estimated that 343 men and 61 women are needed annually for growth alone in the 5 natural scientist groups. Trained natural scientists are, however, also absorbed by a variety of other occupations. The most important of these are the teaching and administrative occupations.

The teaching occupations (including university lecturers) absorb about 30 per cent of the male and 28 per cent of the female graduates with training in natural science. The corresponding percentages for administrative occupations are 17,6 and 1,2

per cent. The training of natural scientists must allow for replacement needs as well as this absorption.

The supply of natural scientists is assumed to be closely correlated to the number of B.Sc. graduates produced by the universities. To ensure that 343 men and 61 women will be available for growth and taking immigration into account, it is estimated that 920 men and 315 women must be trained annually. The estimates of annual average supply are 420 male and 375 women graduates. Comparison of the production of B.Sc. graduates with the estimated demand (Table 6.1) shows that the number of male graduates must be doubled to satisfy the estimated demand while women are in over-supply. Substitution possibilities between men and women are restricted because women have a special pattern of labour force participation. Although it can be expected that employers will be pushed to use women to a grater extent than before, it is expected that most of the substitution will occur in the teaching field. Male natural science teachers will therefore be in short supply. Because of the limited substitution possibilities, the observed sharply declining production trend of male graduates and an estimated increase in demand, it is expected that shortages for male natural scientists will intensify. A demand growth rate of 6,6 per cent for male natural scientists cannot be met. In case the declining production of male graduates since 1968 levels out at about 400 degrees per annum in 1980 it is expected that a growth rate of 3,8 per cent in demand can be met.

The conclusion reached is that if the economic development of the RSA results in the demand for natural scientists as estimated in this report, serious shortages in the production of natural science graduates can be expected during the period 1972-1980. This shortage will mostly be felt in the physical science fields such as chemistry, physics and geology.

HOOFSTUK 8

SAMEVATTING EN SLOT

In hierdie ondersoek word ingegaan op die vraag na en aanbod van natuurwetenskaplikes vir die periode 1972-1980. Die ramings wat in die verslag aangebied word, is veel eerder 'n projeksie van die land se behoeftes wat onder 'n sekere stel aannames sal ontwikkel, as 'n projeksie van werklike indiensneming.

Die basiese inligting wat in die verslag gebruik word, is verkry uit die Mannekragopnames van die Departement van Arbeid vir 1965, 1967, 1969 en 1971; die RGN-opname van Natuurwetenskaplikes in 1971, die bevolkingsensusse vir 1960 en 1970 en ramings van die vraag na arbeid soos verskaf deur die Afdeling vir Ekonomiese Beplanning van die Departement vir Beplanning.

Natuurwetenskaplikes is in 5 groepe verdeel, naamlik die

Biologiegroep
Chemiegroep,
Aardwetenskappegroep,
Wiskundegroep, en
Fisikagroep.

'n Raming van die persentasie wat natuurwetenskaplikes van die totale Blanke arbeidsmag in 1980 uitmaak, is op grond van die veranderinge wat in die beroepstruktuur gedurende 1965-1971 waargeneem is, gemaak. Deur die EOP se raming van die vraag na arbeid te gebruik en met die RGN-opname se aanvulling van sekere gapings in die beskikbare inligting, is die vraag na natuurwetenskaplikes volgens groep in 1980 geraam. Die besonderhede van hierdie raming verskyn in tabel 3.14 volgens groep en geslag.

Die aanbod van natuurwetenskaplikes word op 5318 mans en 584 vroue vir 1971 geraam. Die vraag in 1980 word op 8463 werkgeleenthede vir mans en 1130 vir vroue gestel. Hierdie ramings impliseer 'n jaarlikse groeikoers van 6,6 en 10,4 persent in die vraag na mans en vroue onderskeidelik. Hierdie groeikoerse word as die maksimum wat die vraag kan bereik, beskou. Om aan hierdie vraag te voldoen word geraam dat 343 mans en 61 vroue jaarliks vir groei in die 5 groepe alleen benodig word. Opgeleide natuurwetenskaplikes word in 'n verskeidenheid van ander beroepe geabsorbeer. Die belangrikste hiervan is die onderwys en administratiewe beroepe. Die onderwysberoepe, wat universiteitspersoneel insluit, absorbeer ongeveer 30 persent van die manlike en 28 persent van die vroulike gegradueerdes in die natuurwetenskappe. Die ooreenstemmende persentasies vir die administratiewe beroepe

is 17,6 en 1,2 persent. Die opleiding van natuurwetenskaplikes moet toelaat vir hierdie absorbering sowel as vervanging van natuurwetenskaplikes wat sterf of uit diens tree.

Daar word aanvaar dat die aanbod van natuurwetenskaplikes nou verband hou met die getal B.Sc.-gegradueerdes wat deur die universiteite geproduseer word. Om te verseker dat 343 mans en 61 vroue beskikbaar sal wees vir groei, en nadat immigrasie in aanmerking geneem is, word geraam dat 920 mans en 315 vroue jaarliks opgelei moet word.

Die raming van die jaarlikse gemiddelde produksie is 420 manlike en 375 vroulike gegradueerdes. 'n Vergelyking tussen vraag en produksie (tabel 6.1) toon dat die getal manlike gegradueerdes moet verdubbel om aan die vraag te voldoen, terwyl by vroulike gegradueerdes 'n oorskot bestaan.

Vervangingsmoontlikhede tussen mans en vroue is beperk as gevolg van die eiesoortige patroon van deelname aan die arbeidsmag wat vroue het. Alhoewel dus verwag kan word dat werkgewers verplig sal wees om vroue in 'n groter mate as voorheen te gebruik, word verwag dat die meeste vervanging van mans in die onderwysberoepe sal voorkom. Die aanbod van manlike natuurwetenskaponderwysers sal dus relatief verder verminder. As gevolg van die beperkte vervangingsmoontlikhede, die skerp afname in produksie van manlike gegradueerdes en 'n toename in die vraag, word verwag dat die tekorte aan manlike natuurwetenskaplikes sal toeneem. Dit is ook duidelik dat 'n groeikoers van 6,6 persent in die vraag na manlike natuurwetenskaplikes nie bereik kan word nie. Indien die afnemende neiging in produksie van manlike gegradueerdes, wat sedert 1968 waargeneem is, afplat en teen ongeveer 400 gegradueerdes per jaar in 1980 stabiliseer, sou 'n vraagtoenamekoers van 3,8 persent bevredig kan word.

Die gevolgtrekking waartoe geraak word, is dat indien die ekonomiese ontwikkeling van die RSA 'n vraag soos in hierdie verslag aangedui, ontwikkel, ernstige tekorte aan natuurwetenskaplik opgeleide gegradueerdes gedurende 1972-1980 ondervind sal word. Hierdie tekorte sal veral gevoel word in die fisiese wetenskappe soos Chemie, Fisika en Geologie.

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