Annual Report 1996

Department of Agronomy

Wageningen Agricultural University
Department of Agronomy
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Contents

PREFACE

The Department of Agronomy is one of about sixty departments of the Wageningen Agricultural University. The Department of Agronomy was established after the merging of the former Departments of Field Crops and Grassland Science, and Tropical Crops on 1 September 1992.

A first report, Report 1992-1994, was published in February 1995 and an Annual Report 1995 in February 1996. The present Annual Report 1996 gives an overview of the Department's teaching activities carried out in the academic year 1995/1996 and the Department's research results in the year 1996. Detailed descriptions of all research projects are not included in this volume but can be found in the previous Annual Report 1995 or on the Department's home page on internet: http://www.spg.wau.nl/agro.

In this volume the main results of a restricted number of projects are highlighted and grouped in three research themes.

We expect that this report is of interest to you and look forward to suggestions, as well as to continued or new cooperation.

1 THE DEPARTMENT OF AGRONOMY

1.1 Introduction

The production of food, feed and raw materials is essential for society. Hence, a productive and sustainable agriculture is of utmost importance. Over the past decades, the scientific knowledge on agriculture has increased considerably. This knowledge has contributed to the high productivity of agriculture in many countries. Much has been achieved, but new problems and challenges have arisen. In some areas production increases lag behind population growth. Worldwide, agricultural practices threaten the environment.

In agriculture, man influences the interactions between production systems, crops, grassland vegetation, animals and the natural environment. Insight into the functioning of agro-ecosystems is a prerequisite for developing sustainable production of food, feed and raw materials, and is necessary to promote a better management of land and vegetation.

The ultimate goal is the development of a sustainable agriculture which is profitable and acceptable, conserves the soil and other internal production factors, uses external inputs efficiently and causes minimal damage to the environment.

1.2 Agronomy as a science

Agronomy as a science focuses on human intervention in agro-ecosystems through cropping techniques and management practices in order to obtain useful products for mankind and to promote sustainable land use.

The Department of Agronomy works on solutions for agronomic problems by developing scientific knowledge about the ecology of (grass) vegetations, and the growth of crops for food, feed and raw material. By means of teaching and research, the Department aims to achieve a more thorough understanding of the functioning of agro-ecosystems and to contribute to the development of sustainable agriculture worldwide.

1.3 Mission statement of the Department

In teaching and research the Department of Agronomy has the following aims:

1. to study the biological, physical and chemical aspects of the intervention by man in agro-ecosystems through cropping techniques and management practices, recognizing that these are also determined by socio-economic conditions;
2. to integrate knowledge from other disciplines for the purpose of the analysis, improvement and design of cropping techniques and management practices, and of agro-ecosystems;
3. to study agro-ecosystems at two key aggregation levels: crop/vegetation and cropping system, while also analyzing the underlying ((sub-)plant) and the upperlying (land-use system) levels.

1.4 Sections of the Department

The Crop and Grassland Science section studies the growth of food and non-food crops as influenced by biotic and abiotic factors, including technological and environmental aspects, the quality of raw material and its significance for the storage and processing of plant products, and the production, physiology and nutritive value of forages in temperate and tropical regions and the ecology of grasslands, including grass vegetations for combined agricultural and nature conservation purposes.

The Plant Production Systems section studies existing and improved crop production systems for the (sub)tropics with special emphasis on annual and perennial cropping systems and the development of regional land-use models.

1.5 Facilities

The Department of Agronomy has several lecture rooms, areas for practical training, modern computer facilities and an extensive library at its disposal. Plant and soil samples can be analyzed chemically in the Department's laboratory.

The experimental facilities of several departments belonging to the Sector Plant and Crop Sciences of the University, combined into UNIFARM, the UNIversity Facilities for Agronomic Research and Management, include an experimental farm of 120 ha on different soil types (64 ha heavy river clay, 12 ha very light sand, 7 ha light sand, 37 ha loamy sand) with facilities to house approximately 200 oxen. There are facilities for feeding experiments with animals. In demonstration gardens, many crops and their cultivars, grassland plants and weeds are grown. The major crops of different tropical eco-regions are exhibited in the greenhouses. For experiments under controlled conditions there are greenhouses and growth chambers in which environmental factors like photoperiod, temperature, carbon dioxide concentration and relative humidity can be regulated. There is mobile equipment for photosynthesis and transpiration measurements in the field.

In the Rhizolab Wageningen, a joint facility of the Research Institute for Agrobiology and Soil Fertility (AB-DLO) and the Wageningen Agricultural University, the growth and development of crops above and below ground can be studied.

The Department of Agronomy cooperates with many partners, which are mentioned per research project.

1.6 Personnel

Personnel of the Department of Agronomy on December 31, 1996 is listed in the left hand column, whereas staff members who left the Department during 1996 are mentioned in the right hand column.

Section Crop and Grassland Science

Current staff (31.12.96)

Amaducci, S.[2,5]
Bos, Ir H.J.[6]
Deinum, Dr Ir B.[4]
Elgersma, Dr Ir A.
Elzebroek, A.Th.G.
Engels, Dr F.M.
Illipronti Jr., MSc, R.A.[1,2]
Lommen, Dr Ir W.J.M.
Lootsma, Ir M.[6]
Mannetje, Prof Dr Ir L. 't[4]
Mehari, T.[1,2]
Nassiri Mahalati, MSc, M.[1,2]
Neuteboom, Drs J.H.
Putten, P.E.L. van der
Schlepers, H.
Scholte, Dr Ing. K.
Schouls, Ir J.
Stutterheim, Dr Ir N.C.[2,3]
Struik, Prof Dr Ir P.C.
Tsegaye, A.[1]
Vos, Dr Ir J.
Waaijenberg, Dr Ir H.[3]
Warringa, Ir J.W.[6]
Wind, K.

Staff left during 1996

Almekinders, Dr Ir C.J.M.[6]
Bos, Ir H.J.[1]
Deinum, Dr Ir B.
Dhanapal, MSc, G.N.[1,2]
Groot, Ir J.C.J.[1]
Kerkhoff, Ir P.[6]
Lootsma, Ir M.[1,2]
Tarla, MSc, F.[1,2]
Timmermans, P.C.J.M.
Warringa, Ir J.W.[1,2]

Section Plant Production Systems

Current staff (31.12.96)

Afandi, I.[7]
Belde, J.J.M.
Bessembinder, Ir J.[6]
Brink, Ir M.[6,7]
Brouwer, Dr Ir J.[3]
Flach, Prof Dr Ir M.[4]
Fokkema-Lentink, E.M.[7]
Fresco, Prof Dr Ir L.O.
Gerritsma, Ir W.[2]
Guiking, Ir F.C.T.
Koning, Ir G.H.J. de[1]
Kok, Drs K.[1,2]
Oyen, Ir L.[7]
Ridder, Drs N. de
Schoorl, Drs J.M.[2]
Schuiling, Ir D.L.[2]
Siemonsma, Dr Ir J.S.[7]
Stomph, Dr Ir T.J.
Verburg, Ir P.H.[1,2]
Westphal, Dr Ir E.
Wienk, Dr Ir J.F.
Zeijl-Rozema, Ir A.E. van[2,3]

Staff left during 1996

Berg, Ir M.M. van den[6]
Bessembinder, Ir J.[1]
Brink, Ir M.[1]
Ogtrop, Ir F.G. van[7]
Slaats, Dr J.J.P.[6]

Laboratory staff

Halm, H.D.

[1] PhD-student, [2] external, [3] temporary scientist, [4] retired staff member, [5] partly external, [6] guest, [7] PROSEA

Administrative staff

Bosman, M.P.
Kuijpers, T.W.H.M.[2]
Loualidi, B.[2]
Schouwenburg, I.C. van[5]
Visser-Kamstra, G.J.

Computer centre staff

Romberg, J.A.
Soolsma, J.

[2] external, [5] partly external

Visiting scientists and guests during 1996:

R.D. Amendola (Mexico)
W. Araia (Eritrea)
Dr Ir R.M.T. Baars (Zambia/Ethiopia)
Z. Bishaw (Syria)
Dr H.J. Jung (USA)
T. Mehari (Eritrea)
Dr K. Rickert (Australia)
J.A. Saluzzo (Argentina)
Dr Ir A. van Schoonhoven (Syria/Colombia)
Dr L. Thombiano (Burkina Faso)

1.7 Organizational structure

The Department Board decides on matters relevant for teaching and research.
On December 31, 1996 the following persons were member of the Department Board (the first seven members listed form the Executive board of the Department on December 31, 1996):

P.C. Struik (chairperson)
L.O. Fresco (vice-chairperson)
J.F. Wienk (secretary, manager)
A. Elgersma (coordinator for external relations)
A.Th.G. Elzebroek (representative of the technical staff)
J. Vos (coordinator for research)
E. Westphal (coordinator for teaching)

J.J.M. Belde
M.P. Bosman
J. Brouwer
R. Cornelissen*
F.M. Engels
F.C.T. Guiking
E.J. Hommes*
W.J.M. Lommen
A. van der Maden*
J.H. Neuteboom
P.E.L. van der Putten
N. de Ridder
K. Scholte
J. Schouls
J.S. Siemonsma
B. Sterk*
T.J. Stomph
N.C. Stutterheim
P.H. Verburg
K. Wind

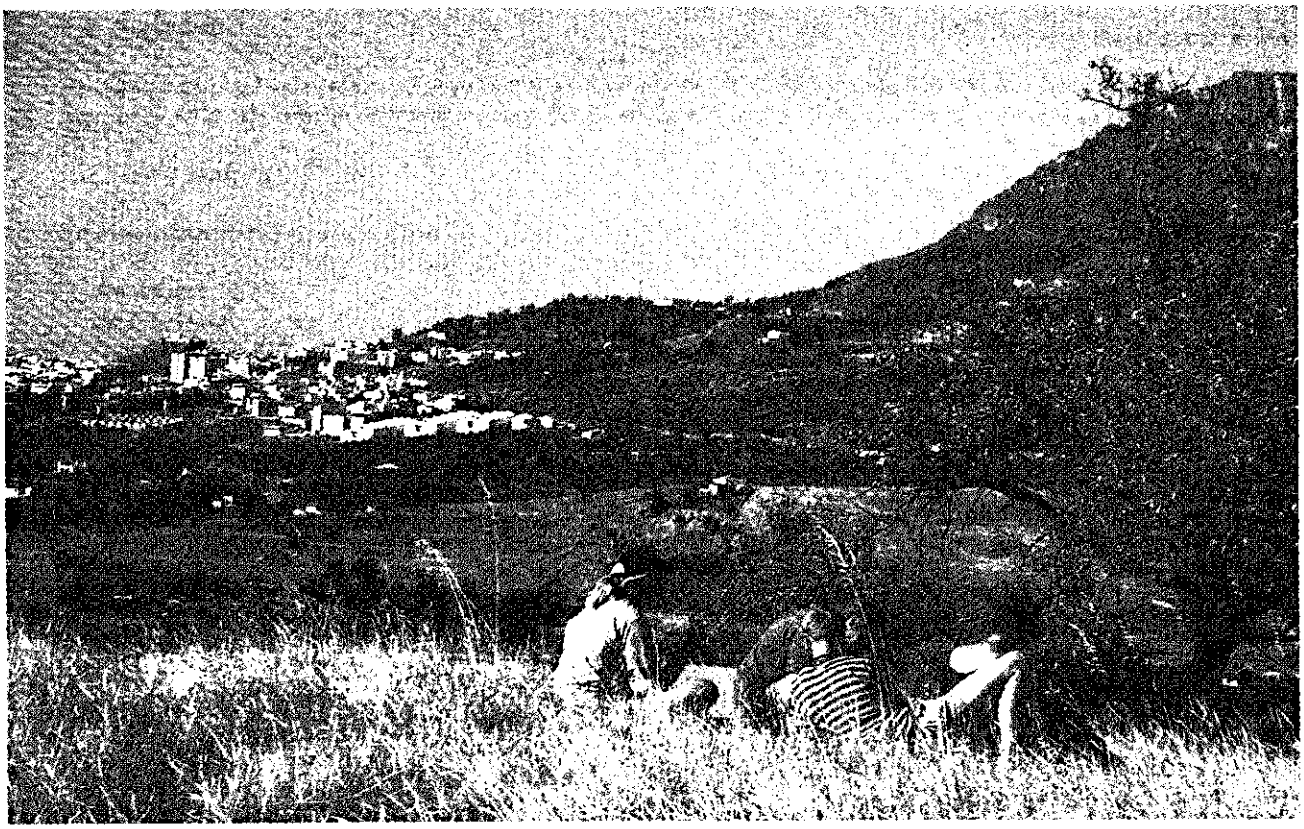
* Student members

During 1996 the following members left the Department Board:
J. Bessembinder, H.J. Bos, B. Deinum, J.C.J. Groot, F.W. Oberthür*, J.A.J. van Soesbergen*, G. Wink*

From 1 January 1996 on, L.O. Fresco assumed the chair of the Advisory Council for Research on Nature and Environment (RMNO) for a period of 3 years and J. Brouwer was temporarily appointed to assist her in teaching and research tasks.

Heads of sections during 1996:

Professor L.O. Fresco, Plant Production Systems (tropics and subtropics).
Professor P.C. Struik, Crop and Grassland Science.



2 TEACHING

2.1 Introduction

At present there are 19 degree courses at the Wageningen Agricultural University. They train students to obtain the degree of "ingenieur" (Ir). The Department of Agronomy teaches students of many different degree courses, but especially students of those of Crop Science (T10, meanwhile merged with T12 into Plant Production Sciences), Tropical Land Use (O10), Rural Development Studies (O20), and Animal Sciences (T20). The Department is also involved in international courses for students from developing countries, such as the MSc courses Crop Science, Animal Production, Ecological Agriculture and Agroforestry.

The Department focuses its teaching and research on a better understanding of interactions between environmental factors and primary production as influenced by management. Its main objective is the development of the scientific requirements for sustainable production systems, primarily on the basis of crop physiology and ecology.

The emphasis in teaching is on the analysis of agro-ecosystems and on the development of sustainable alternatives. A thorough knowledge of the physiology and ecology of crops and grassland is a prerequisite. This knowledge is integrated at higher levels (cropping system, farm, watershed, region), using information from other disciplines such as soil science or farm economics. Methodology of research and analysis is a major part of the curriculum.

Objectives are to attain knowledge, insight and skills in relation to different aspects of plant production in a multitude of agro-ecological and social-economic situations, all based on a solid background of basic and associated sciences. This refers to, on the one hand, the general principles involving the influence of environmental factors on the behaviour of plants and crops in relation to productivity, quality and effects on the environment; and on the other hand, the general principles of cropping techniques which influence the development, productivity, quality and environmental effects. Besides these general principles, specific knowledge and insight in the different crops are necessary.

After an introductory phase in which knowledge in the basics of agricultural science and land use is taught, subjects covering general processes in ecology and crop science follow. Within the so-called "problem-oriented courses", students learn to recognize, formulate and solve agricultural problems. Methods of research and analysis are taught in practicals in Wageningen and in Spain.

An important part of the degree courses is the practical training period. For this, students often go abroad. During four to six months, students obtain working experience and an impression of future professional career opportunities.

During the latter part of the curriculum, the student carries out a research project under the supervision of a member of the scientific staff and writes a MSc-thesis. Thus, the student gains research experience: i.e. developing a hypothesis, designing and executing research, analysis and interpretation of data, and reporting. Some students write a thesis with a stronger emphasis on professional skills.

A graduate agronomist is an academic who can analyze complex problems and convert them into answerable questions. He or she should also be capable of integrating this knowledge at higher aggregation levels such as a farm or a region. The analysis of competing goals of society at large may play an important role in this. Thanks to a helicopter view and a problem-solving and practice-oriented approach, these scientists may play a leading role in the radical changes which must take place in the present world's agriculture.

Employment of graduate agronomists is quite diverse. They may work in the Netherlands or abroad, in research institutes, government organizations, educational organizations (e.g. universities), development organizations, consultancy agencies, the (agro)industry or in commerce.

2.2 Degree course programmes

In the academic year 1995/96 the following functions in degree course programmes were carried out by members of the Department of Agronomy:

Tropical Land Use (O10):
- student advisor: F.C.T. Guiking (for the specialization Tropical Crop Science)
- chairperson exam committee: L.O. Fresco

Crop Science (T10):
- student advisor: J. Schouls
- chairperson course committee: P.C. Struik*
- secretary course committee: W.J.M. Lommen
- chairperson exam committee: P.C. Struik

Professional Master Agronomy (T10P):
- secretary: J. Schouls
- member: P.C. Struik*
- chairperson exam committee: P.C. Struik

Plant Production Sciences (T16):
- secretary: W.J.M. Lommen
- advisor: J. Schouls

Animal Sciences (T20):
- advisor course committee: B. Deinum (until July 1996)

MSc course Ecological Agriculture:
- member programme committee: P.C. Struik*
- member exam committee: P.C. Struik

* Later withdrawn, to allow membership of the board of the Undergraduate School Life Sciences

2.3 Student numbers

The number of students per course given by the Department of Agronomy is listed below for 1995/'96

Code	Course	Total student number	Distribution of students among various degree course programmes: B	L10	L30	L50	L60
F350-001	Stage landbouwplantenteelt (P3)	7	-	-	-	-	-
F350-003	Beschrijvende landbouwplantenteelt	33	-	-	-	-	9
F350-004	Practicum gewassenkennis (gem. gebied)	25	-	-	-	-	5
F350-005	Kennis van tropische gewassen	94	-	1	-	-	-
F350-006	Tropisch landgebruik	93	1	3	-	-	-
F350-007	Tropische gewassen en teelttechnieken in relatie tot duurzame teeltsystemen	97	-	2	-	1	-
F350-008	Praktijksimulatie tropen	89	-	-	-	-	-
F350-009	Practicum graslandbotanie	17	1	-	-	-	3
F350-010	Practical tropical grassland*	6	-	-	-	-	-
F350-200	Praktijkweek oogsthandelingen	25	-	-	-	-	15
F350-202	Practicum plantaardige produktie	13	1	-	-	-	-
F350-203	Teelt en biologie van akkerbouwgewassen	9	-	-	-	-	2
F350-205	Algemene graslandkunde	39	2	-	-	-	10
F350-207	Tropical grassland*	13	2	-	-	-	-
F350-209	PGO I: landbouw in bedrijfsverband	7	-	-	-	-	-
F350-210	PGO II: landbouwplt. en graslandkunde	7	-	-	-	-	-
F350-211	Analyse van literatuur	9	-	-	-	-	-
F350-212	Onderzoeksmethodieken	26	-	-	-	-	-
F350-213	Produktkunde	9	-	-	-	-	3
F350-214	- 217 Capita selecta grasland[1]	17	1	-	-	-	1
F350-218	- 220 Capita selecta akkerbouw[1]	33	-	-	-	-	-
F350-223	Excursie buitenland	2	-	-	-	-	-
F350-227	Literature analysis*	3	-	-	-	-	-
F350-228	Milieu-aspecten van de landbouw	21	-	-	-	-	-
F350-229	Graslandoecologie	4	1	-	-	-	-
F350-230	Teelt en kwaliteit van ruwvoeders	8	-	-	-	-	4
F350-231	Capita selecta agronomie B[1]	14	-	-	-	-	-
F350-232	Onderzoeksmethodieken II	18	-	-	-	-	-
F350-300	Landbouw en teeltsystemen*	69	-	3	-	-	-
F350-302	Verdieping ecol., teelttechniek en gewas	13	-	-	-	-	-
F350-304	Gewasbotanie	1	-	-	-	-	-
F350-305	Open vak agronomie B	4	-	-	-	-	-
F350-306	- 308 Capita selecta tropla[1]	21	-	-	-	2	-
F350-309	Colloquia tropische plantenteelt	12	-	-	-	-	-
F350-310	Binnenlandse excursie tropla	-	-	-	-	-	-
F350-311	Projectstudie tropische plantenteelt	3	-	-	-	-	-
F350-312	Veldpract. duurz. landgebruik, ond. tropla	14	-	-	-	-	1
F350-315	Ecofysiol. grondslagen van de teelt*	22	-	-	-	2	1
F350-316	Open vak agronomie A	3	-	-	-	-	-
F350-317	QUASI*	17	-	-	-	-	-
F350-318	PGO bodem en teelt	17	-	-	-	-	-
F350-600	Stage agronomie (12)	1	-	-	-	-	-
F350-601	Stage agronomie (15)	13	-	-	-	-	-
F350-602	Stage agronomie (21)	5	-	-	-	-	-
F350-603	Stage agronomie (27)	1	-	-	-	-	-

* taught in English
[1] units of 1 credit point

Distribution of students among degree course programmes during 95/96, continued.											Total student number during		
M10	M21	O10	O20	T10	T12	T15	T20	T32	MSc	Misc.**	93/94	94/95	95/96
-	-	-	-	7	-	-	-	-	-	-	11	6	7
16	-	-	-	7	-	1	-	-	-	-	52	39	33
10	-	-	-	7	-	1	1	-	-	1	52	30	25
3	-	51	38	-	-	-	-	-	-	1	97	78	94
-	-	52	36	-	-	-	-	-	-	1	96	92	93
4	-	49	36	-	-	2	-	-	-	3	102	89	97
-	-	50	39	-	-	-	-	-	-	-	85	69	89
-	-	1	-	7	-	-	4	-	-	1	23	21	17
-	-	4	-	-	-	-	-	-	-	2	18	26	6
-	-	1	-	9	-	-	-	-	-	-	17	29	25
-	-	-	-	11	-	-	-	-	-	1	13	12	13
-	-	-	-	3	-	4	-	-	-	-	9	14	9
-	-	1	1	7	-	-	17	-	-	1	42	38	39
-	-	7	1	-	-	-	-	-	2	1	26	29	13
-	-	-	-	6	-	-	-	1	-	-	5	12	7
-	-	-	-	7	-	-	-	-	-	-	11	4	7
-	-	-	-	8	-	-	-	-	-	1	11	8	9
-	-	10	-	7	-	-	-	-	5	4	25	24	26
-	-	-	-	1	-	2	-	-	-	3	5	6	9
-	-	6	-	1	-	-	7	-	-	1	53	61	17
-	-	2	-	31	-	-	-	-	-	-	38	55	33
-	-	-	-	2	-	-	-	-	-	-	4	14	2
-	-	-	-	-	-	-	-	-	3	-	9	2	3
1	-	1	-	13	-	1	4	-	-	1	8	15	21
-	-	2	-	-	-	-	1	-	-	-	-	-	4
-	-	1	-	-	-	-	3	-	-	-	-	-	8
-	2	4	2	4	-	-	-	-	2	-	-	-	14
-	-	9	-	6	-	-	-	-	-	3	-	-	18
-	-	41	3	2	-	1	1	-	15	3	117	68	69
-	-	13	-	-	-	-	-	-	-	-	12	15	13
-	-	1	-	-	-	-	-	-	-	-	11	9	1
-	-	2	-	2	-	-	-	-	-	-	5	-	4
-	-	13	2	3	-	-	-	-	-	1	51	26	21
-	-	11	-	1	-	-	-	-	-	-	8	7	12
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	3	-	-	-	-	-	-	-	-	1	-	3
-	-	11	-	2	-	-	-	-	-	-	11	8	14
-	-	5	-	7	-	-	-	1	6	-	32	42	22
-	-	3	-	-	-	-	-	-	-	-	2	31	3
-	-	11	-	4	-	-	-	-	2	-	4	13	17
-	-	15	-	2	-	-	-	-	-	-	10	17	17
-	-	-	-	1	-	-	-	-	-	-	6	4	1
-	-	7	-	5	1	-	-	-	-	-	15	8	13
-	-	3	-	2	-	-	-	-	-	-	10	5	5
-	-	-	-	1	-	-	-	-	-	-	1	2	1

**Miscellaneous = L14, L20, M30, T13, T30, T31, T34
For descriptions of degree courses, see Studiegids (Study guide) 1995-1996

The number of students that completed a MSc thesis during 1995/96 at the Department of Agronomy.

Code	Thesis (credit points)	Total	Bio	L10	L40	L50	O10	T10	T11	T13	T32	MSc
F350-700	AV Crop Science (9)	2	-	-	-	-	-	2	-	-	-	-
F350-701	AV Crop Science (13)	3	-	-	-	-	-	3	-	-	-	-
F350-703	AV Crop Science (21)	5	-	-	-	-	-	4	-	1	-	-
F350-638	AV Crop Science (21)	1	-	-	-	-	-	1	-	-	-	-
F350-716	Thesis Agronomy (27)	1	-	-	-	-	-	-	-	-	-	1
F350-704	AV Grassland Science (9)	2	-	-	1	-	-	-	-	1	-	-
F350-706	AV Grassland Science (17)	1	-	-	1	-	-	-	-	-	-	-
F350-707	AV Grassland Science (21)	2	1	-	-	-	1	-	-	-	-	-
F350-717	Thesis Grassland (27)	1	-	-	-	-	-	-	-	-	-	1
F400-700	AV Tropical Crop Science (9)	1	-	-	1	-	-	-	-	-	-	-
F350-713	AV Tropical Crop Science (13)	3	-	-	2	1	-	-	-	-	-	-
F350-714	AV Tropical Crop Science (17)	4	-	-	3	-	1	-	-	-	-	-
F400-621	AV Tropical Crop Science (17)	1	-	-	-	-	-	-	1	-	-	-
F400-701	AV Tropical Crop Science (17)	1	-	-	-	-	-	-	1	-	-	-
F350-715	AV Tropical Crop Science (21)	3	-	1	1	-	1	-	-	-	-	-
F400-703	AV Tropical Crop Science (21)	1	-	-	-	-	1	-	-	-	-	-
F350-718	AV Tropical Crop Science (27)	7	-	-	4	-	1	1	-	-	1	-
F300-703	AV TPE (21) - 20%*	1	-	-	-	-	-	1	-	-	-	-
K075-704	AV GIS (27) - 40%*	2	-	-	-	-	-	-	-	-	-	2
F800-704	Thesis Ecol. Agriculture - 100%*	1	-	-	-	-	-	-	-	-	-	1

*Percentage contribution by Agronomy

2.4 Other teaching activities

The following members of the Department of Agronomy participated in other teaching activities:

Contributions in courses of other Departments of WAU:

- H. Schlepers in Animal nutrition on the farm, E350-207
- W.J.M. Lommen in Production of seed and propagules, F750-205

Contributions in courses of the International Agricultural Centre (IAC Wageningen):

- W.J.M. Lommen, P.E.L. van der Putten, K. Scholte and P.C. Struik in International Potato Course: Production, Storage and Seed Technology
- H. Schlepers and K. Wind in Dairy Production and Rural Development
- F.C.T. Guiking in Nutrient Management for Sustainable Agriculture
- J.S. Siemonsma in Vegetable Course

Contributions in the "Stage sur les Plants de Pomme de Terre":

- W.J.M. Lommen and P.C. Struik

Contribution in Stichting Kennisoverdracht, Plantenveredeling en -vermeerdering (SKP):

- W.J.M. Lommen

2.5 Improvement of lecture notes

During 1996 the study materials of the following courses were renewed or updated:

W.J.M. Lommen.
Kwaliteit van uitgangsmateriaal: Kiemkracht en vigour van zaaizaad. F 350-218

J. Vos, A.Th.G Elzebroek, K. Scholte.
Milieu-aspecten van de landbouw. F350-228

A. Elgersma and F. Engels.
Teelt en kwaliteit van ruwvoer. F350-230

N. de Ridder.
QUASI. F350-317

T.J. Stomph.
Praktijksimulatie tropen. F350-008

T.J. Stomph.
Ecofysiologische grondslagen van de teelt. F350-315

2.6 Computer-based interactive multimedia education programme on tropical crops

In 1993, D.L. Schuiling began to explore the possibilities to upgrade the introductory course on tropical crops (F350-005) with a computer-based interactive multi-media component.

A project group was formed in which scientists of the Departments of Communication and Innovation Studies, and Agricultural Education took part. The group discussed the educational, media, and technical aspects of such a computer-based education programme. A sketch prototype was produced and presented in January 1994.

During 1996 D.L. Schuiling finalised a full prototype of this programme called TROPCROP, which includes an extensive electronic encyclopedia on tropical crops and a course on tropical crop recognition and identification. The course was evaluated by the Department of Agricultural Education. The results were promising.

2.7 Restructuring of the teaching programme

Mainly in the context of the merger in 1996 of the degree courses Crop Science (T10) and Horticulture (T12) into the new degree course Plant Production Sciences (T16), the Department of Agronomy had to restructure its teaching programme.

At present the Department is developing a number of new courses:

- Plant production and society;
- Introduction in plant production (crop/vegetation level);
- Knowledge of plants and crops (practical, plant/crop/vegetation level);
- Problem-oriented course on sustainable plant production (case study including analysis of agronomic problems and design of solutions);
- Grassland and forage science;
- Ecophysiological principles of crop production;
- Growth and quality of forages;
- Quantitative analysis of plant and crop growth & development.

Moreover, the Department is involved in developing courses on agro-ecology (A and B), agrobiodiversity, methodology of designing, and others.

2.8 MSc theses in the period January - December 1996

Section Crop and Grassland Science

Arndorfer, M., 1996. Occurrence of *Tilletia caries* (Common bunt) in winter wheat seed from ecological farms in Austria.
Boer, A.J.C., 1996. Groeikracht en kwaliteit van pootaardappelen.
Hart, A. ter, 1996. Bepaling uittrekkrachten in aardappelloof.
Hoornsman, A., 1996. Effect van uitwendige omstandigheden op de groei en ontwikkeling van kandidaatlokgewassen.
Jong, C.J. de, 1996. Persistence of forage legumes on sandy soil.
Kivunge, K.E., 1996. Yield formation in field crops grown from potato minitubers of different weight classes.
Lamers, J.T.W.H., 1996. Effecten van een verlaging van de stikstofgift op de opbrengst, de kwaliteit en de kroonroestresistentie van Engels raaigras (*Lolium perenne* L.).
Lammers, J.W., 1996. Ontwikkeling van een alternatieve produktiemethode voor aardappel-miniknollen.
Lenssinck, F., A. Looman & R. Veerman, 1996. Stikstofbenutting in de melkveehouderij.
Loon, T.S. van, 1996. Bestrijding van aardappelcysteaaltjes met behulp van lokgewassen.
Muijs, G., 1996. Validatie en evaluatie van PIEteR, een bio-economisch produktiemodel voor suikerbieten.
Pellikaan, W.F., 1996. The effects of artificial shade and natural canopy shade on understorey herbage quality and quantity.
Prins, F., 1996. Invloed van het gewicht van aardappelminiknollen op parameters die de opbrengst onder veldomstandigheden bepalen. II. Opkomst, uitval, loofontwikkeling en grondbedekking.
Roding, G.H.M., 1996. Gevolgen van verminderde inputinzet op opbrengst en milieubelasting van een gangbaar akkerbouwrotatiesysteem.
Schrader, P., 1996. Crop residues. A comparison of the nutritive values of cereal straws, pulse straws and sugar cane tops.
Schulte, R.P.O., 1996. Interference model for production vegetations.
Simon, G., 1996. Nutrient flows in continuous cultivation of silage maize and the effect of undersown grass.
Soesbergen, M.A.T. van, 1996. Invloed van verschillende behandelingen tijdens de opkweek van in vitro geproduceerde aardappelplanten op de droge stofproduktie en -verdeling tijdens de veldgroei.
Starren, M.H.C.W., 1996. Anatomie en verloop van verteerbaarheid in het blad van Italiaans raaigras (*Lolium multiflorum* Lamb.).
Tigchelaar, E.R., 1996. Efficiëntie van stikstof en herbiciden bij de teelt van suikerbieten in Oostelijk Flevoland.
Vink, J.G., 1996. Sucros 3. Potato. Simulation of the effects of nitrogen on growth and development of potato.
Waterink, A., 1996. Invloed van het gewicht van aardappelminiknollen op parameters die de opbrengst onder veldomstandigheden bepalen. I. Tijdstip knolinitiatie, drogestofverdeling, oogstindex en knolsortering.
Wyngaert, I. van den, 1996. Growth and degradation characteristics of the pastures in the Mindif-region, North-Cameroon.

Section Plant Production Systems

Admiraal, A. & M.E. Bokhove, 1996. The role of Napiergrass (*Pennisetum purpureum*) in nutrient management of livestock systems in Kakamega and Kisii Districts, Kenya.
Bolink, P.M., M.H. Groeneveld & P.L.M. Nooyens, 1996. Erftuinen in Suriname, Nigeria en India. Gewassen en hun functies.
Groot, S., 1996. Charactérisation du terrain au moyen des transects: nombre minimal et les endroits les plus qualifiées.
Horen, P. van, 1996. Computer ondersteund onderwijs toegepast voor het practicum Kennis van Tropische Gewassen.
Jonge, I.W. de, 1996. The influence of land use driving forces on cocoa production in Ghana.
Kool, S.A.M. de & I.M.M. Schimmel, 1996. On-Farm Validation of the Potato Growth Model LINTULPLUS and its Sub-Models on Drought and Late Blight.
Kop, P.J. van de, 1996. Regional scale nutrient balances for agro-ecosystems in Ecuador.
Lammertink, M., 1996. Screening regeneranten van cassave (*Manihot esculenta* Crantz) verkregen uit somatische embryogenese.
Rienks, S., 1996. Schaaleffecten in oppervlakkige afstroming.
Roeland, R., 1996. Incorporating effects of drought on potato (*Solanum tuberosum* L.) in LINTULPLUS Model.
Roovers, J., 1996. Plant species as indicators of the hydromorphic zone.
Wiegers, E.S., 1996. Dynamics of the sectoral fallowing system. Land use change in the upper canete valley, Peru.
Wijffels, M., 1996. Farm typology incorporating actual land use: a low-data input approach for the Guanaste Province, Costa Rica.
Wilk, C. van der, 1996. Improvement of the yield potential and disease resistance of bread wheat in Mexico between 1962 and 1995.

3 RESEARCH

3.1 Introduction

Agricultural production will need to grow substantially in the coming decades to meet the needs of the growing world population and of continued economic growth and consumer demands. This will increase the pressure on the natural resources of soil, water and air which are being affected and degraded in many parts of the world. Agriculture needs to meet the rising demand for marketable output, while satisfying ever tighter constraints with respect to the quality of its products and the impact of production techniques on humans, nature, environment, landscape and (other) resources.

These issues require a comprehensive and integrated scientific analysis of socially relevant options for agricultural production activities at crop, farm, region and supra-regional levels. Such an analysis should focus on developing sustainable agricultural production systems that are in harmony with the environment.

How can present land use systems, including their agricultural components, be changed to achieve sustainable agricultural production in an environmentally safe, biologically sound and socially and ethically acceptable manner?

The aim of our current research is to increase insight in the production-determining factors by analysis of growth and development of crops. Optimal use of production-determining factors can be achieved by manipulation of the environment, based on fundamental knowledge of the processes of crop growth, in order to optimize sustainable crop production. Through simulation studies and experiments these processes and their interactions are being studied. Crop production should be maintained or increased with optimal use of fertilizers and minimal losses to the environment for an ecologically sustainable crop production system.

The effect of growth reduction of biotic stress agents (pests, diseases and weeds) should be minimized in an ecologically sound way. Environmentally acceptable control methods are being developed to manage growth-reducing factors within the context of sustainable crop management.

New and environmentally-safe cultivation strategies, which are less prone to or preventative of weed, disease and pest problems are studied. Furthermore, our research should produce methodologies to analyze agricultural production systems, to explore scenarios for the development of sustainable and productive production systems at different scales that comply with multiple goals set by the farmer and society with respect to agriculture, nature and the environment. These systems must be based on an efficient use of natural resources, while protecting the environment by establishing location-specific options for their development.

The research programme of the Department of Agronomy is focused on various aspects and scales of agro-ecosystems, from plant physiology and crop or grassland ecology to land use. The methods of research range from experiments or surveys in the laboratory, the greenhouse, the field or the valley to computer simulation.

The Department's research is of a fundamental nature and is focused on ecological and physiological processes in agro-ecosystems. Although practical application is not the first objective, the Department collaborates with more practice-oriented research institutes and experiment stations. Research projects are often conducted together with other departments of the Wageningen Agricultural University or with other universities or research institutes in the Netherlands and abroad.

Against this background, three major research themes were identified at the Department of Agronomy: Yield and quality of plant and crop production; Analysis and design of agro-ecosystems; and the overarching theme Resource use efficiency. These themes are studied at various levels of aggregation. The emphasis of the section Crop and Grassland Science (CGS) is on crop/grassland vegetation level and of the section Plant Production Systems (PPS) on cropping system/land use system level. A selection of recent research results will be highlighted below.

Section	*Level of aggregation*	*Research theme*	
	(sub)plant		
CGS ▸	crop/grassland vegetation	**Yield and quality of plant- and crop production**	**Resource Use Efficiency**
PPS ▸	cropping system	**Analysis and design of agro-ecosystems**	
	land use system		

3.2 Research highlights

3.2.1 Resource use efficiency
J. Vos, A. Elgersma and M. Nassiri

Nitrogen as a resource for plant production

Agricultural production results from applying management to resources. Nutrients are one of the resources for plant production. There are many options for management of the availability of nutrients. Nitrogen is particularly important because its sparse natural availability limits crop production. Availability has been increased by using external input, i.e. nitrogen fertilizers, and by enhancing biological nitrogen fixation via cultivation of legumes.

Nitrogen is subject to different routes of transformation in the soil-plant-animal system and can escape in different forms from the agro-ecosystem to the environment. Optimal use of resources requires insight in processes at various levels of organization, e.g. plant, crop or grassland vegetation, and cropping or grazing system. At each level measures can be taken to increase the utilization efficiency and decrease losses to the environment.

Nitrogen and plant development

At the Department of Agronomy plant responses are being studied. In field crops, emphasis was on the quantification of the effect of nitrogen regimes (amount and timing) on component development and growth processes, including the rate and duration of leaf appearance, the rate and duration of leaf expansion, the total number of leaves formed per plant, specific leaf weight, life span of leaves, partitioning of dry matter, total nitrogen and nitrate over component plant parts and rate of light saturated photosynthesis. Plant species studied were potato, Brussels sprouts, leek and spinach. Few processes were responsive to nitrogen supply: the rate of leaf expansion and the number of leaves per plant (for indeterminate species); relative distributions of nitrogen and dry matter were not or hardly affected by nitrogen. Nitrogen affected leaf size, but not the light saturated rate of photosynthesis per unit leaf area. Change in nitrogen regime (i.e. from 'low' to 'high' or vice versa) resulted in rapid change in plant nitrogen concentration, followed by slower changes in leaf size and leaf weight.

Nitrogen and grass-legume mixtures

Legumes are being studied in projects on Bambara, various grain and forage legumes in Bolivia, Arachis and Erythrina in Costa Rica, and white clover.
In grass-clover mixtures, the aim is to gain insight into mechanisms that determine clover persistence under various management strategies. Differences are being identified between contrasting grass and clover cultivars.

The rate of appearance, expansion and fate of grass and clover leaves and the investment of resources into new leaf tissue (total leaf area and vertical distribution) are studied. This basic information is needed to explain changes in the composition of mixtures and to improve existing simulation models on competition between plants and on capture of the resource light. The spatial and temporal rates of change in leaf area, dry matter and radiation absorption were studied at weekly intervals in successive 5-cm canopy layers. There were large differences in leaf area and dry matter distribution over height between mixtures. Similarly, differences between cutting frequencies were found, which changed during the season. Leaf area and radiation absorption profiles were different in clover and grass. They also differed among contrasting clover cultivars, resulting in different patterns of dry matter distribution.

The vertical distribution of leaf area in mixed canopies of large-leaved and small-leaved clover cultivars was estimated by using an inclined point quadrat, as a tool for formulation of the role of competition for light in crop growth models. The within species leaf dispersion of grass and clover showed significant effects on light absorption patterns (Fig. 1).

Leaf CO_2 assimilation rate (A_{max}) of species in different depths within the canopy and leaf nitrogen content over height were measured during the season. In both species A_{max} was highly correlated with leaf N (Fig. 2). For each species a profile in leaf N content was found, which followed the light extinction patterns and led to a profile for A_{max} with depth in the canopy. These results will be used for improving the photosynthesis sub-models in the existing simulation models for inter-plant competition in mixtures.

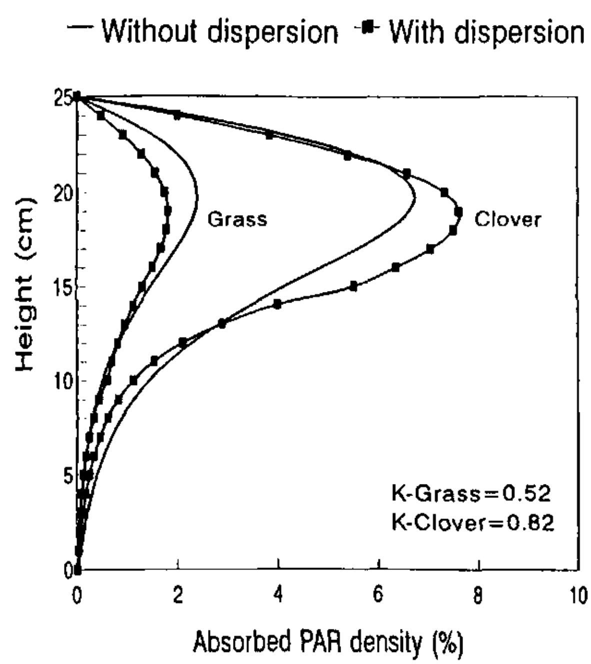
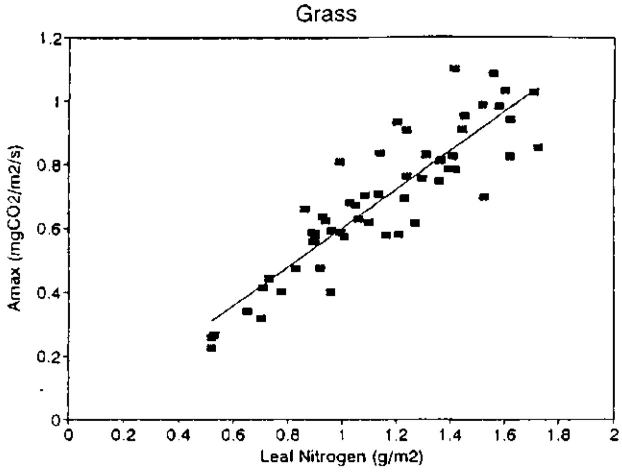


Fig. 1. The effect of dispersion on absorbed PAR in grass and clover at different canopy heights.



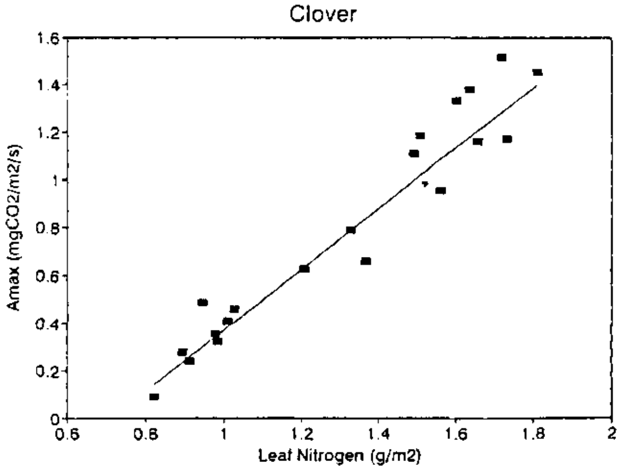


Fig. 2. The relation between A_{max} and leaf N in grass and clover.

Nitrogen and emissions to the environment

To control N losses, insight into the N fluxes in above and below-ground pools is necessary. Therefore, relations between crop and soil parameters were studied in a cutting trial with perennial ryegrass monocultures and grass - white clover mixtures. Herbage yield, the amount of nitrogen fixed by clover, N transfer to companion grasses, dynamics of nutrients and organic matter in the soil and nitrate (NO_3^-) emissions were measured.

Mixtures with the large-leaved clover cv. Alice yielded significantly more herbage and clover DM, had a higher clover content and showed more NO_3^- losses than mixtures with cvs. Gwenda and Retor.

Mixtures with Alice also had the highest rate of potential N mineralization on one sampling date in November 1994, but on other sampling dates differences among clover mixtures were not significant. In the layer 0-10 cm the C:N ratio of the soil organic matter (most pronounced in the active fractions) was higher under grass than under grass-clover mixtures, which may account for the lower N mineralization under grass.

Nitrogen catch crops can play a role to enhance nitrogen utilization at the level of the cropping system. Cropping systems were studied with catch crops as an experimental factor. The general conclusion is that with catch crop cultivation, 30 to 50 kg ha^{-1} can be saved on nitrogen input. The reduction in the nitrate concentration in the leachate is in the order of 40 to 50 ppm. Separate studies with catch crops species, sowing date and nitrogen regime as experimental factors underlined the importance of sowing-date as a determinant of nitrogen accumulation. For sowings between end of August and end of September nitrogen accumulation dropped from ca 140 to 15 kg ha^{-1} for treatments without N limitation (average of four seasons). Intercepted radiation explained most of the variation in crop growth rate, irrespective of species, sowing date and nitrogen regime.

3.2.2 Bio-ecological control of soil-borne pathogens
K. Scholte

Lower yields and/or poor quality of crops grown in short rotations cannot be ascribed to a single pathogen only, but are the result of the combined effects of a complex of harmful and non-harmful organisms. Pathogenic organisms interact mutually with the non-pathogenic soil flora and fauna, with the abiotic environment, with the crops and cultivars grown in the rotation and with cultural practices. Cultural practices may affect directly or indirectly the population density of harmful soil organisms. Studying the mechanism of action of cultural practices contributes to the prevention of damage on crops by pathogens and reduces the dependency on chemical control.

The efficacy, interaction and magnitude are investigated of the effect of various cropping practices on the population density of a natural population of harmful soil organisms and the consequences for the crops grown. The cultural practices should either diminish soil infestation level and the reproduction rate of plant pathogens, or should stimulate the soil flora and fauna antagonistic to these pathogenic organisms.

Trap crops to control potato cyst nematodes

The potato cyst nematodes (PCN) *Globodera rostochiensis* and *G. pallida* are a serious problem in potato growing areas. Infestation can result in substantial yield reductions. Within each species various pathotypes/virulence groups occur. Short crop rotations including potato will result in a distinct increase in soil infestation with PCN. In the absence of a host plant a limited number (20-30%) of juveniles will hatch spontaneously from the cysts. This will result in a gradual decrease in the population. However, under these circumstances it can take 15 years for all the juveniles to hatch from the cysts. When a potato crop is grown, hatching will increase significantly (up to over 80%) as a result of the stimulating effect of potato root diffusates. Thus, growing a trap crop resistant to PCN but with hatching inducing characteristics comparable to potato would seem an efficient control method.

Approximately 100 non-tuber bearing *Solanaceae* were screened for resistance to and hatching effect on PCN. Four candidate trap crops were selected. All the candidate trap crops grew better under long day (17 h) than under short day (12 h) conditions, but the crops were sensitive to low temperatures. Compared to potato grown from seed tubers, their initial growth was slower but later on they produced a greater shoot mass and a much more extensive root system. In a pot experiment, hatching of juveniles from cysts of *G. rostochiensis* was promising (Fig. 3).

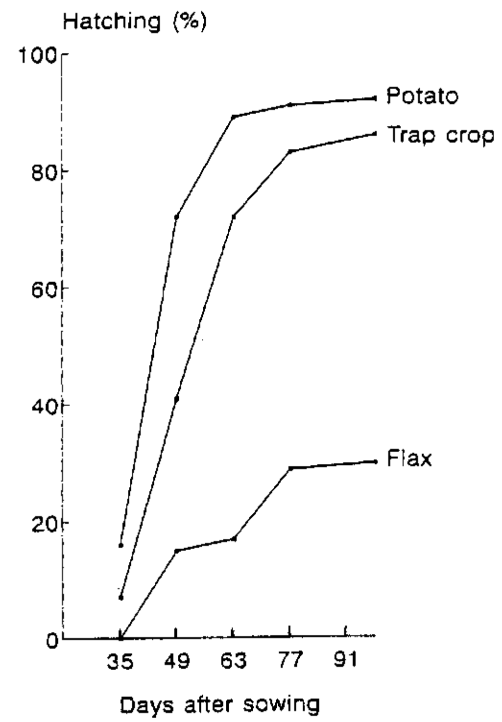


Fig. 3. Hatching of *G. rostochiensis* juveniles by potato, a trap crop, and a control crop (flax).

Stimulating the soil fauna antagonistic to *Rhizoctonia solani*

Rhizoctonia solani (AG-3) is a soil-borne plant pathogen causing canker on potato stems and stolons. Severe canker results in delayed emergence, fewer emerged stems, lower tuber yield and a high proportion of small, partly green and misshapen tubers with a lower dry matter content. The pathogen survives for several years in the soil by sclerotia. Sclerotia can also be formed on progeny tubers (black scurf).

Rhizoctonia stem and stolon canker can be reduced by the soil fauna; especially collemboles and mycophagous nematodes can feed directly on the mycelium of *R. solani*. These animals are indigenous in arable field soils. From 1991 to 1994 a two year lasting field experiment was conducted twice to assess the possibility of suppressing Rhizoctonia stem canker by increasing population densities of these mycophagous organisms. Several soil treatments with organic amendments (green manure crops and farmyard manure) were applied in the autumn/winter season. These treatments enhanced the populations of the mycophagous soil fauna and consequently the severity of Rhizoctonia stem canker was reduced. Effects of environmental factors on the potential suppression of Rhizoctonia stem canker by the springtail *Folsomia fimetaria* and the mycophagous nematode *Aphelenchus avenae* were investigated in growth chambers. Low soil temperature and relatively dry soil conditions, which are favourable for Rhizoctonia stem canker, enhanced the suppressive potential of these organisms. The effect of adding dried forage rape (*Brassica napus* ssp. *oleifera*) material to the soil on the suppressing ability of *F. fimetaria* and *A. avenae* to *R. solani* depended on the composition of the organic material and on soil pH.

3.2.3 Scale dependency of variables driving water and nutrient flows

N. de Ridder, T.J. Stomph, N.C. van de Giessen and L.O. Fresco

In all projects of the section Plant Production Systems scaling is a major research issue. One of the research topics is the scale dependency of variables driving the water and nutrient flows. Progress made in this topic, in particular in the research project "Development of a multi-scale model of rice-based agro-ecosystems in West Africa", will be highlighted in the following.

A conceptual multi-scale water balance model has been developed in which a watershed can be divided into columns equal in length and width, but varying in height determined by the altitude derived from topographical data. The model describes a one-dimensional water balance for each column and a three-dimensional distribution of water at watershed level. The scale-dependency of run-off, one of the driving forces in the water balance, is mimicked by the introduction of a reduction factor (REDF). This factor may vary between 0 (run-off water is considered to have no opportunity to re-infiltrate down-slope) and 1 (all run-off is considered to have the opportunity to re-infiltrate down-slope). Using the characteristics of a watershed representative for West Africa, the model is used to study the effects of land use changes on the run-off at watershed level. Two land use types differing in vegetation have been distinguished, a perennial woody vegetation and an annual vegetation (i.e. crops). These vegetation types differ in their values of REDF. The model is run changing land use by replacing step-by-step columns with perennial woody vegetation by crops. Fig. 4 presents the results of the calculated run-off at the watershed level. Run-off is expressed as a fraction of the maximum value for run-off when the entire watershed is occupied with crops. The dotted line represents the relation between run-off and the proportion of the two land use types, if spatial scale dependency is not taken into account (REDF = 1). The dashed lines represent the solution domain, if spatial scale dependency is explicitly modelled (REDF < 1 and varying per land use type). Run-off can vary for one particular land use combination (x-axis; proportion of woody perennial vegetation to crops) between the two dashed lines, depending on the location (uplands, slopes or bottom lands) of the two land use types within the watershed. The letter combinations in this figure indicate possible combinations of woody perennial vegetation (W) and annual crops (C). The first, second and third place in the combination indicate the uplands, the slopes and bottom lands of the watershed, respectively.

The model demonstrates the importance of spatial scale dependency of variables driving water and nutrient flows. Furthermore, it shows the effect of spatial patterns of land use on these flows at the watershed level. Thus, the reduction factor as applied in this model needs further investigation.

REDF depends on characteristics such as slope length, slope, micro-relief, vegetation and on the influence of agricultural practices on these characteristics. To unravel these different aspects, field experiments, measuring the run-off of plots differing in size, are ongoing in Burkina Faso and Ivory Coast. Some results are presented in Fig. 5. In this figure, the ratio of the run-off of plots of 10 m^2 to that of 1 m^2 plots for rainfall events in the 1995 rainy season is plotted in time (day 0 is the 31[th] of May and day 150 is the 28[th] of October). A ratio of one means no scale effect, whereas a smaller ratio indicates a scale effect. Average seasonal run-off of 1 m^2 plots was 40% of the rainfall, whereas run-off of 10 m^2 plots was 26% of the rainfall. Rainfall in the experimental area is bi-model, with a short rainy season from April to July, followed by a short dry season in July and the principal rainy season from August to the end of October. Scale effects seem to be less important in the most humid period of the principal season (August and September), when soils become saturated, than in the rest of the year. However, this effect may be counteracted by the development of a crop during that same period: vegetation is expected to increase scale effects. Further experiments are needed to unravel these different effects, but it may be concluded that the scale dependency of run-off changes over time, related to changes in time of the different aspects determining this scale dependency.

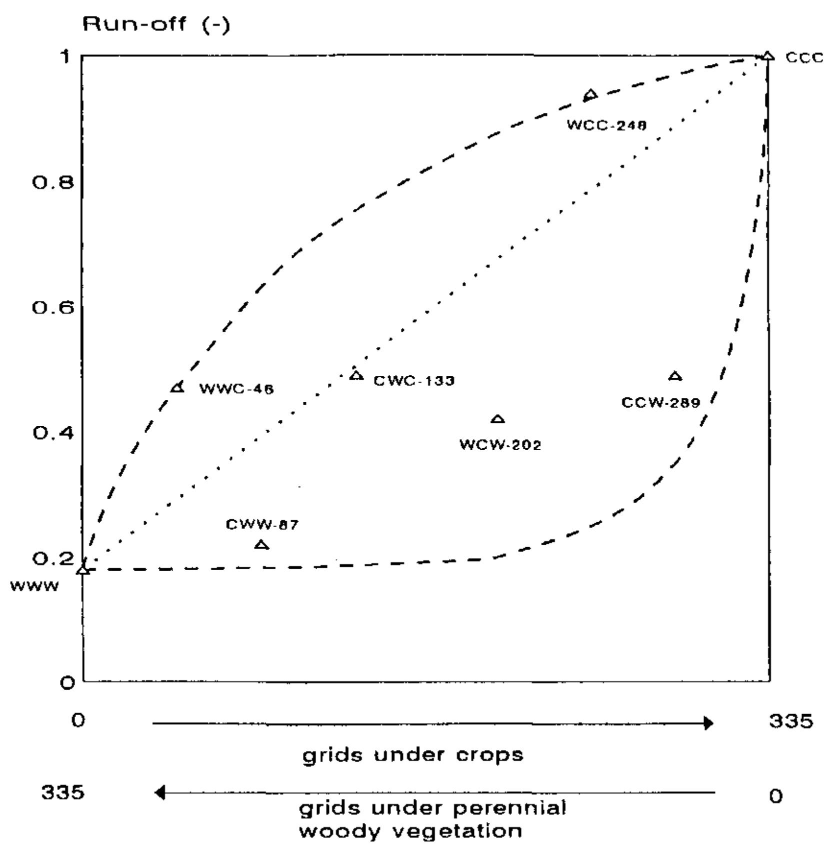


Fig. 4. The solution domain of run-off values of an inland valley in relation to replacement of two land use types (crops and perennial woody vegetation). The run-off is expressed as fraction of the maximum run-off obtained when the inland valley is fully covered with crops.

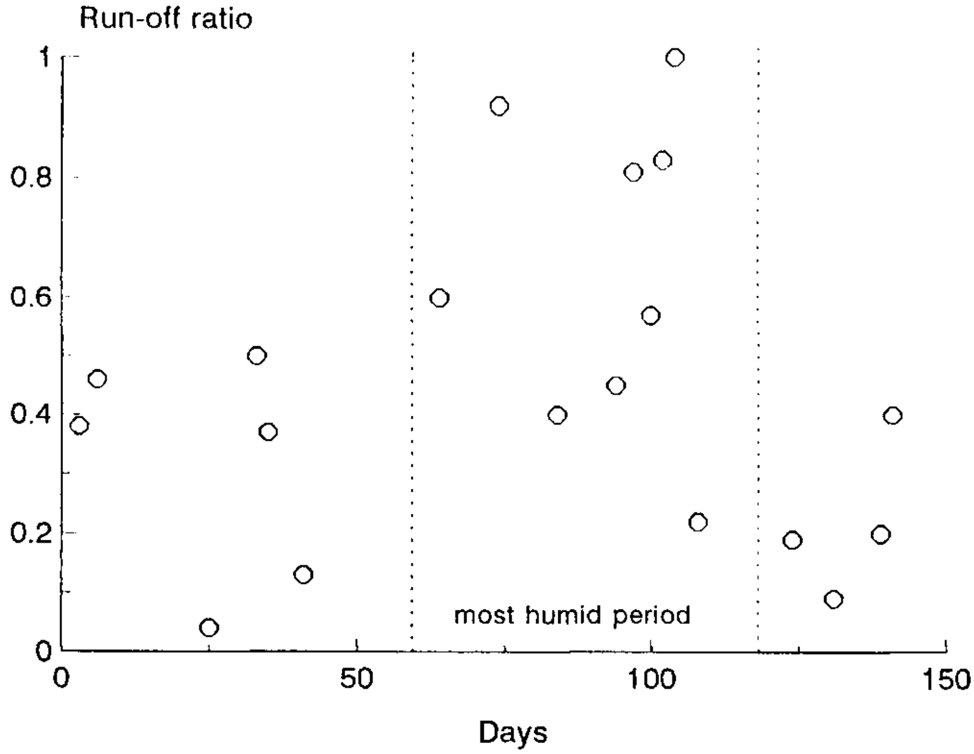


Fig. 5. The ratio of the run-off per unit area of 10 m^2 plots to the run-off per unit area of 1 m^2 plots for major 1995 rainfall events in Ivory Coast (Bouaké).

3.3 List of research projects

The current research projects of the Department of Agronomy are listed below for each section. More detailed information was presented in the Annual Report 1995, and current information and progress can be found on our home page.

3.3.1 Section Crop and Grassland Science

Manipulation of tuber size distribution of potato (*Solanum tuberosum* L.)
Researchers : P.C. Struik, W.J.M. Lommen
Project leader : P.C. Struik
Term : 1982-1999
Research school : PE
Cooperation with : Department of Plant Physiology, WAU, AB-DLO, PAV

Production and quality of propagation material
Researchers : W.J.M. Lommen, R.A. Illipronti Jr.
Project leader : W.J.M. Lommen
Term : 1994-1998
Research school : PE
Form : R.A. Illipronti Jr.: PhD-project
Cooperation with : CPRO-DLO

Growth of arable crops in intensive cropping systems with environment-friendly control strategies against soil pathogens
Researcher : K. Scholte
Project leader : K. Scholte
Term : 1994-2001
Research school : PE

Trap crops as an environmentally friendly cultural practice to control potato cyst nematodes
Researcher : K. Scholte
Project leader : K. Scholte
Term : 1995-1999
Research school : PE

Analysis of input-output relations of nutrients on the level of crop and region for different systems of nutrient management
Researchers : J. Schouls, G.O. Nijland
Project leader : J. Schouls
Term : 1993-1998
Research school : WIMEK
Cooperation with : Department of Ecological Agriculture, WAU

Analysis of the development and functioning of crops in relation to environmental factors, nitrogen in particular
Researchers : J. Vos, P.E.L. van der Putten
Project leader : J. Vos
Term : 1988-1998
Research School : PE

Physiology of grasses in relation to development and digestibility of cell walls
Researcher : B. Deinum
Project leader : B. Deinum
Term : 1992-1997
Research school : WIAS
Cooperation with : CPRO-DLO

Physico-chemical research of lignocellulose synthesis in primary and secondary cell walls of plant tissues
Researcher : F.M. Engels
Project leader : F.M. Engels
Term : 1992-1998
Research school : WIAS

Productivity and botanical composition of grasslands for nature conservation
Researchers : J.H.Neuteboom, K. Wind
Project leader : J.H. Neuteboom

Persistence of white clover in permanent grassland
Researchers : *A. Elgersma, H. Schlepers*
Project leader : A. Elgersma
Term : 1991-1997
Research school : PE

Modelling interactions in grass-white clover mixtures
Researcher : M. Nassiri Mahallati
Project leaders : A. Elgersma, E.A. Lantinga
Term : 1994-1998
Research school : PE
Cooperation with : Department of Theoretical Production Ecology, WAU

The agronomy of grain and pasture legumes in Bolivia
Researchers : H. Waaijenberg, J. Jiménez
Project leader : H. Waaijenberg
Supervisor : L. 't Mannetje
Term: : 1994-1998
Financer : DGIS
Cooperation with : Centro de Investigación Agrícola Tropical (CIAT); Centro de Investigación en Forajes (CIF) de la Universidad Mayor de San Simón; Programa Nacional de Leguminosas de Grano (PNLG) del Instituto Boliviano de Tecnología Agropecuaria (IBTA); Department of Microbiology, WAU

Hemp for Europe
Researcher : N.C. Stutterheim

Project leaders	: P.C. Struik, N.C. Stutterheim
Term	: 1996-1998
Financer	: EU
Cooperation with	: ADAS (GB); CPRO-DLO (NL); ECCO GmbH (BRD); FNPC (Fr); IAF (BRD); Univ. di Bologna (I); Silsoe Res. Inst. (GB); The BioComposites Centre (Wales-GB)

Agronomic and physiological analysis of the effects of multiplication and handling techniques on the rate of multiplication and quality of in vitro produced potato plantlets and their subsequent performance during hardening and after transplanting into the field

Researcher	: Tadesse Mehari
Project leaders	: W.J.M. Lommen, P.C. Struik
Research school	: PE
Term	: 1996-2000
Form	: PhD project
Cooperation with	: CAAS, University of Asmara, Asmara, Eritrea
Financer	: MHO/NUFFIC

3.3.2 Section Plant Production Systems

Aspects of agricultural practices in relation to land-use planning

Researchers	: L.O. Fresco, N. de Ridder, T.J. Stomph
Project leader	: L.O. Fresco
Term	: 1992-1998
Research school	: PE
Cooperation with	: Consortium for sustainable use of inland valley agro-eco-systems in sub-Saharan Africa, with IITA, WARDA, SC-DLO and national agricultural research agencies (NARS)

Development of a multi-scale model of rice-based agro-ecosystems in West Africa

Researchers	: N. de Ridder, T.J. Stomph
Project leader	: L.O. Fresco
Term	: 1993-1998
Research school	: PE
Cooperation with	: WARDA (Dr N.C. van de Giessen); Departments of Soil and Water Conservation and Soil Tillage, WAU

Collective research for agro-technological growth and quality model for cocoa

Researcher	: W. Gerritsma
Project leader	: M. Wessel
Term	: 1996-1999
Financers	: Bensdorp, Cacao de Zaan, Dutch Cocoa, Gerkens Cacao & Mars

CLAUDE - Coordination land use and cover data and analysis in Europe

Project leader	: M.L. Parry (University College London)
Program officer	: A.E. van Zeijl-Rozema
Term	: 1996-1998
Financer	: EU

Modification of soil processes by mulching in the humid tropics

Researchers	: F.C.T. Guiking, D.M. Jansen
Project leader	: F.C.T. Guiking
Term	: 1993-1995

Agro-ecological niches in Andean potato growing

Researchers	: G.H.J. de Koning, L.O. Fresco
Project leader	: G.H.J. de Koning
Term	: 1994-1998
Form	: PhD project
Cooperation with	: International Potato Center (CIP)

Spatial and temporal upscaling of regional, land use related, methane emission

Researchers	: P.H. Verburg, L.O. Fresco
Project leaders	: N. van Breemen, L.O. Fresco
Term	: 1996-2000
Cooperation with	: Departments of Soil Science and Geology, Microbiology and Theoretical Production Ecology, WAU; IMAU (University of Utrecht); International Rice Research Institute (IRRI) and others

Multi-scale land use modelling

Researchers	: J.M. Schoorl, K. Kok and L.O. Fresco
Project leader	: L.O. Fresco
Term	: 1996-2000
Research School	: PE
Form	: PhD-project
Financers	: NOP-II (National Research Programme on Air Pollution and Climate Change)

Plant resources of South-East Asia (PROSEA)

Researchers	: J.S. Siemonsma, E. Westphal, L.P.A. Oyen, M. Brink
Project leader	: J.S. Siemonsma
Term	: 1985-2000
Cooperation with	: P.C.M. Jansen, R.H.M.J. Lemmens, M.S.M. Sosef, E. Boer (Department of Plant Taxonomy, WAU)

3.3.3 Sandwich PhD projects

Persistence and productivity of herbaceous and woody legumes in grassland improvement in the tropics

Researcher : S. Abarca Monge
Supervisor : L. 't Mannetje
Term : 1993-1998

Diversity, competition, yield stability and yield level of mixtures of wheat and barley landraces in the Central Highlands of Eritrea

Researcher : Woldeamlak Araia
Project leader : P.C. Struik
Research school : PE
Term : 1996-2000
Cooperation with : CAAS, University of Asmara, Asmara, Eritrea
Financer : MHO/NUFFIC

Systems analysis of potato production and its constraints in Argentina

Researcher : D.O. Caldiz
Project leaders : P.C. Struik, A.J. Haverkort
Research school : PE
Term : 1996-2000
Cooperation with : Instituto de Fisiologia Vegetal, Facultad de Ciencias Agrarias y Forestales, Universidad de la Plata, La Plata, Argentina; AB-DLO
Financers : Universidad de la Plata, WAU

Studies on potential yield, agronomy and biodiversity of enset in Ethiopia

Researcher : Admasu Tsegaye
Project leader : P.C. Struik
Research school : PE
Term : 1996-2000
Cooperation with : Awassa College of Agriculture, Awassa, Sidamo, Ethiopia; University of Bangor, UK
Financers : Awassa College of Agriculture, WAU

Farmers seed source and quality: implications for seed programmes

Researcher : Z. Bishaw
Project leaders : P.C. Struik, A.J.G. van Gastel, M.C. Saxena
Research school : PE
Term : 1996-2001
Cooperation with : ICARDA
Financers : ICARDA, WAU

Agronomic analysis of potato cultivation in Sichuan, China

Researcher : He Wei
Project leaders : P.C. Struik, Tan Zonghe
Research school : PE
Term : 1994-1997
Cooperation with : CIP regional office in China; Sichuan Academy of Agricultural Sciences
Financers : Crops Institute, SAAS; WAU; Japanese potato processing firm

Quantitative analysis of dry matter production in vegetable crops as affected by environmental factors

Researcher : J.A. Saluzzo
Project leaders : P.C. Struik, A.J. Haverkort
Research school : PE
Term : 1996-1998
Cooperation with : Facultad de Ciencias Agrarias, Univ. Nac. de Mar del Plata, Argentina; AB-DLO
Financers : UNMP, WAU

Yield gaps in potato in the Ecuadorian Andes

Researcher : J. Korva
Project leaders : L.O. Fresco, A. Haverkort (AB-DLO)
Research school : PE
Term : 1994-1998
Cooperation with : International Potato Center (CIP)
Financers : CIP, Finnish Academy of Sciences

Linking land use types to landforms and soils to assess soil water erosion risk

Researcher : P.F. Okoth
Project leaders : L.O. Fresco, E. Smaling (SC-DLO)
Term : 1994-1998
Cooperation with : SC-DLO, Kenya Soil Survey (KSS)
Financers : KSS, DGIS

Making cooperatives work. Contract choice and resource management within land reform cooperatives in Honduras

Researcher : R. Ruben
Project leaders : H. Linnemann (VU), L.O. Fresco, H. Thomas
Term : 1994-1997
Cooperation with : VU

3.3.4 Projects that ended in 1996

The development of a location specific bio-economic production model for tactical decision support in sugar beet growing, with special reference to yield, quality and environment

Researcher : A.B. Smit
Supervisors : P.C. Struik, J.A. Renkema, J.H. van Niejenhuis (WAU); F.G.J. Tijink (IRS)

Period : 1992-1996
Form : PhD project
Cooperation with : Institute for Sugar Beet Growing (IRS); Department of Farm Management (WAU)

Management of broomrape *(Orobanche cernua* Loefl.) in tobacco (*Nicotiana tabacum* L.)
Researcher : G.N. Dhanapal
Supervisors : P.C. Struik, S.J. ter Borg
Period : 1992-1996
Form : PhD project (sandwich)
Cooperation with : University of Agricultural Science, Bangalore (India); Department of Terrestrial Ecology and Nature Conservation (WAU)

Analysis of factors facilitating biotic breakdown of reed stems (*Phragmites australis*) used for thatching
Researcher : A.Th.G. Elzebroek
Project leader : P.C. Struik
Period : 1993-1996

Degradation of rangelands
Researcher : F. Tarla Nchembi
Supervisors : L.'t Mannetje, J.H. Neuteboom
Period : 1993-1996
Form : PhD project (sandwich)
Cooperation with : Cameroon: Centre d'Etude de l'Environnement et du Développement au Cameroun, Maroua. The Netherlands: Centrum voor Milieustudie Leiden

Agro-ecological analysis of regional land use scenarios
Researchers : J. Bessembinder, L.O. Fresco, R. Rabbinge, M.K. van Ittersum
Project leader : L.O. Fresco
Term : 1992-1996
Form : PhD-project
Cooperation with : Centro Agronomico Tropical para Investigacion Enseñanza, Ministerio de Agricultura y Ganadería, Universidad Nacional in Costa Rica and WAU

Land Use and Cover Change as an overarching topic in the Dutch National Research Programme on Global Air Pollution and Climate Change
Researchers : M.M. van den Berg and A.E. van Zeijl-Rozema
Project leader : L.O. Fresco
Term : 1995-1996
Financed by : the National Research Programme on global air pollution and climate change

Cultivation techniques to control *Rhizoctonia solani* on potato
Researcher : M. Lootsma
Project leaders : K. Scholte, J. Vos, P.C. Struik
Term : 1991-1996
Research school : PE
Form : PhD-project

The effect of environmental factors on crop canopy structure
Researcher : H.J. Bos
Project leaders : J. Vos, J.H. Neuteboom, P.C. Struik
Term : 1992-1996
Research school : PE
Form : PhD-project

Physiological aspects of seed formation in grasses
Researcher : J.W. Warringa
Project leaders : W.J.M. Meijer, A.J.C. de Visser, P.C. Struik
Term : 1992-1996
Research school : PE
Form : PhD-project
Cooperation with : AB-DLO
Co-financer : Stichting Nederlands Graan-Centrum

Relation between mechanical and histological properties of grass leaves
Researcher : P. Kerkhoff
Project leader : B. Deinum
Term : 1995-1996

Simulation of *in-vitro* digestibility of grass on the basis of morphological and physiological plant characteristics
Researcher : J.C.J. Groot
Project leaders : J.H. Neuteboom, E.A. Lantinga, B. Deinum
Form : PhD-project
Term : 1992-1996
Research school : PE
Cooperation with : Department of Animal Nutrition; Department of Theoretical Production Ecology

Evaluating the potential for bambara groundnut as a food crop in semi-arid Africa
Researcher : M. Brink
Project leader : E. Westphal
Term : 1993-1996
Cooperation with : International research programme "Evaluating the potential for bambara groundnut as a

food crop in semi-arid Africa"
Financer : EU

3.4 Summaries of PhD theses, completed in 1996

Management of broomrape *(Orobanche cernua* Loefl.) in tobacco (*Nicotiana tabacum* L.)
Dhanapal, G.N.

Tobacco is an important commercial crop in India. Broomrape (*Orobanche cernua*) is a debilitating holoparasitic weed in all tobacco growing areas in India, with a devastating effect on the crop. In India, yield loss in tobacco ranges from 30-70%; at present hand weeding is the only practice in India applied to control the parasite.

With this background, several laboratory and field experiments were conducted in Karnataka State, Southern India, to study the germination biology and to develop a suitable method to induce the germination of the parasite, and to develop a technology by integrating agronomic and chemical approaches to control the parasite at different phases.

The germination phase of the parasite is a critical period. The seed bank of the parasite can be reduced by stimulating the germination through chemicals, natural host stimulants or both. GR24 (a strigol analogue) at 0.1 and 1.0 ppm, was the standard to assess potential germination. Of the other chemicals, gibberellic acid at 10 and 20 ppm was most effective. The stimulating effects of host plants were significant even when GR24 was applied. Suicidal germination of the parasitic seeds triggered by growing trap crops reduced the weed population and the growth of the host plants was stimulated due to the green manuring effect of trap crops. Therefore, including a trap crop in the rotation may reduce the problem. Sunhemp (*Crotalaria juncea* L.) and greengram (*Vigna radiata* L.) are promising trap crops in a cropping system containing bidi tobacco in areas where tobacco is grown in a long growing season.

Chemical control by (systemic) herbicides is also an option. Maleic hydrazide (MH) reduced broomrape spikes at 0.25-0.75 kg a.i./ha applied at 30 or 40 days after transplanting (DAT) tobacco. Higher tobacco yields were obtained with 0.25 kg a.i./ha MH, which was on par with the hand weeding treatment both in "infested" and "non-infested" tobacco plants. Higher concentrations of MH were toxic to the tobacco crop. Glyphosate at 0.50 kg a.i./ha applied at 60 DAT and imazaquin at 0.01 kg a.i./ha applied at 30 DAT reduced the broomrape population by almost 80% and increased tobacco leaf dry weight by more than 40% compared to the control treatment. Imazapyr and EPTC were less effective.

Swabbing natural plant oils killed the bud and stem parts of the parasite by suffocation. Neem, coconut and sunflower oils showed quick knock-down effects in killing the bud part, whereas neem oil did not kill the stem part of the parasite. Niger, castor and mustard oils appeared to be (somewhat) less effective.

In general, there is a negative linear relation between broomrape infestation and tobacco yield, with a very large (negative) regression coefficient.

No single method is effective in controlling the parasite. The seed bank of the parasite should be minimized in a phased manner by integrating cultural and chemical methods of control. Therefore, an integrated management strategy is the best perspective to control broomrape in a crop wherever it is problematic.

PIEteR: a field specific bio-economic production model for decision support in sugar beet growing
Smit, A.B.

To support decisions in sugar beet growing, a model, PIEteR, was developed. It simulates growth and production of the crop in a field-specific way, making a tailor-made approach in decision taking possible.

PIEteR is based on causal regression analysis of Dutch data of mostly experimental sugar beet fields. Its prototype, which only simulated root and sugar yields, was selected through a test on the performance of four models and extended with a number of parameters: sugar content, (K+Na) and α-amino-N contents, extractability index, tare content, operating receipts (a measure for gross returns), and amounts of leaves and nitrogen in leaves and crowns after harvest. Growth and production rates are corrected by a water balance module.

The effects of plant density, nitrogen availability and harvest date were modelled and included in PIEteR, thus improving its applicability and the accuracy of the predictions. The profitability of resowing after a poor crop establishment was studied and critical plant densities were given for several combinations of sowing and resowing dates. The profitability of a delay in harvest depends to a large extent on the question whether the sugar yield has exceeded the sugar quota level or not. A method to allocate equipment costs to crops, making tactical decisions on sugar beet area possible, was described and included in PIEteR.

Validation of PIEteR on a set of commercial and experimental sugar beet fields showed average prediction errors for root and sugar yields and financial returns per ha of 12%, 13% and 13%, respectively, and the variances accounted for were 52%, 51% and 50%, respectively. A major part of the prediction errors was caused by the prediction error of the sugar content and by the use of average regional instead of local yield and quality levels.

Improvements on PIEteR can contribute to successful use in practical applications, such as: 1) decision support at farm and field level; 2) industrial campaign planning; 3) yield gap analysis; 4) analysis of new cropping techniques, new cultivars, etc. Further research on the prediction of local levels of output parameters seems to be the most important option for improvement of PIEteR, followed by addition of modules for weeds, diseases and pests, cultivars and preceding crops.

Condition and management of the rangelands in the Western Province of Zambia
Baars, R.T.M.

A land evaluation for extensive grazing was conducted to determine the potential carrying capacity (CC) of the Western Province of Zambia. A hierarchical land classification resulted in Land Regions (9), Land Systems (32), Land Units (124) and Land Facets (415). The vegetation was surveyed, resulting in a 1:500,000 map of landscapes and grasslands. Mid dry season grazing capacities were assessed for the delineated Land Units. Grazing management systems were surveyed. Two transhumance and two sedentary grazing management systems were described. The calculated CC of one transhumance system was close to the actual number of cattle present. In the other systems, the calculated CC's greatly exceeded actual stocking rates. The total provincial CC was estimated at 1,075,000 Tropical Livestock Units. There is room to increase cattle numbers by about 500,000 head. Surface water development could further increase the CC by about 200,000 head. An additional study showed that the condition of the rangelands in high cattle density areas ranged from poor to good. The extremes very poor and extremely good were not encountered. There were no signs of overgrazing. Fire plays an important role in range management, despite the general poor regrowth after burning.

An economic analysis at herd level indicated the increase in cattle numbers, cattle sales, ploughing and milk production as the major sources of income. Manure, transport and local slaughter played minor roles. The economic output of 1.4 US $ per ha per year was considered low. There is a high potential to increase cattle numbers and improve livestock productivity.

Ammonia volatilization from intensively managed dairy pastures
Bussink, D.W.

During the last decade it became clear that NH_3 emissions from agriculture are substantial and that they are causing negative effects on the natural environment. The first emissions inventories were rough estimates due to lack of data. Quantification of the magnitude of NH_3 losses was needed to improve these inventories in order to improve the predictions of NH_3 emission/deposition on the natural environment. Furthermore there was a need to investigate how to reduce NH_3 emissions to decrease the negative effects on the environment. NH_3 losses were studied of N fertilized grasslands under grazing by dairy cows, of mown N fertilized grassland during regrowth, of cattle slurry application and of N fertilizers.

The main findings of the experiments described in this thesis are as follows.

Volatilization of NH_3 on grazed pastures could be related to N excretion, N application rate and cation exchange capacity, which resulted in a calculation procedure to estimate NH_3 volatilization. Grassland mown-only and fertilized according to current recommendations showed a net uptake of aerial NH_3 during grass regrowth. NH_3 fluxes in grassland mown-only had a diurnal pattern as well as a pattern during the grass regrowth period. Reabsorption of emitted NH_3 by grazed swards is important. The amount of short-term rainfall and temperature after N fertilizer application determine the observed differences in N efficiency between urea and calcium ammonium nitrate, between years as well as between countries. Acidification is a good method to reduce NH_3 emissions from surface applied slurry. With a simple relationship it was possible to calculate the required pH in order to meet a target emission reduction. It was recognized that a whole farm approach is needed to reduce NH_3 emissions and to prevent the increase of other N losses.

Prélèvement avant maturité des feuilles et des tiges du mil (*Pennisetum glaucum*): l'utilisation comme fourrage et l'effet sur le rendement en grains (Removal of leaves and stems of pearl millet (*Pennisetum glaucum*) before maturity: use as forage and effect on grain yield)
Tielkes, E.

To cope with rapid population growth and tendencially decreasing annual precipitation, smallholder farmers in the Sahelian zone increasingly shorten fallow periods, expand the area of cultivated land and increase their livestock herds. This development strongly jeopardizes the inherently low soil fertility. The productivity of cultivated land can be stabilized and maintained through effective application of dung and especially animal manure. Systems of close integration between agriculture and livestock husbandry should therefore be reinforced. One possibility for this integration is demonstrated by a traditional system of simultaneous utilization of pearl millet (*Pennisetum glaucum*) for grain production and animal feed, practised in the Dogon country of Mali. Research focused on three major issues:
- Investigation of traditional agricultural practices in the Sono-Bankass region with special emphasis on millet cultivation;
- Quantitative and qualitative analysis of the influence of pre-harvest biomass removal (harvesting of tillers and/or leaves before grain harvest) on grain yield, vegetative growth and fodder production of pearl millet;
- Controlled experiments with cattle and sheep to determine the *in vivo* digestibility of harvested millet biomass in fresh and conserved form (hay, silage).

The survey in the Sono-Bankass region showed that of the time spent on agricultural activities by sedentary farmers 83% are dedicated to millet cultivation. The main objective of millet production is the supply of grain for human consumption, whereby millet makes up for 90% of the regional feed requirements. Farmers identified the highly variable rainfall distribution and the low soil fertility as the most prominent problems for millet cultivation, leading to low numbers of 3000-4000 plants per hectare and grain yields of only 400 to 800 kg per hectare. Due to rapid population growth and lack of arable land, the farmers not only shorten fallow periods but also reduce the area regularly left under fallow. Natural pastures around the villages almost completely disappeared. To feed their draught animals farmers harvest weeds growing in fields as well as biomass from field borders and trees. In the end of September, when the grains are in milk stage, farmers start to partly defoliate pearl millet so as to use the harvested biomass for animal feed. At that moment the millet forage has a higher nutritive value than the available natural vegetation.

Removal of biomass prior to grain harvest generally reduced grain yield if carried out before the grains reached dough stage. Grain yield is determined by number of panicles and grain weight per panicle. If tillers were removed during stem elongation or during flowering, grain yield reduction was due to fewer panicles. Overall, defoliation did not influence the number of panicles but reduced the grain yield per panicle; grain weight was only reduced under total defoliation executed before dough stage of the grain.

With regard to the observed difference in feed quality and taking into account the labour requirement as well as the various difficulties involved in silage conservation in the tropics, green millet biomass should preferably be conserved as hay.

Summarizing, after ten days from the start of flowering, the practice of defoliating millet is an interesting source of animal feed. If the plant is left with the three upper leaves, grain yield will only slightly be affected if executed on fields with organic matter application. The nutritive value of millet biomass harvested in this way is higher than that of feed collected from the natural vegetation available at the same moment. The reduced grain yield due to pre-harvest removal of biomass is compensated for by the good quality forage obtained and by the benefits resulting from adequate nutrition of selected animals like draught animals, cows in early lactation, or fattened rams.

Factors influencing smallholder cocoa production
Taher, S.

The objectives of the study were to expand present knowledge on the technology adoption and application rates for production inputs and fermentation processing related to farmers' decision-making, and to formulate an optimal technology application policy, particularly for smallholder cocoa farmers.

The study developed and tested (1) a model that assesses factors which explain cocoa farmers' technology adoption and application, and (2) a model that presents the optimization of cocoa farmers' activities both at the cocoa farmer and regional level. The research was carried out in South-Sulawesi, Indonesia.

In the last two decades the development of the farming system in the region, dominated by cocoa, changed profoundly. This is due to the land suitability and the dynamic behaviour of indigenous and migrant farmers in adopting and making use of the technology and resources available. Farmers' decisions in adopting cocoa technology were determined by the origin of farmers, the number of neighbours known intimately, the level of education, the size of the family workforce and farm gross output factors, while for application technology they were determined by the number of neighbours known intimately, education level, the amount of family labour, crop area exploited annually and farm gross output factors. Fertilizer adoption was explained by the origin of farmers, the number of neighbours known intimately and the amount of family labour. Pesticide adoption was explained by education level, the amount of family labour and farm gross output factors. Herbicide adoption was affected by the factor origin of farmer. Fermentation adoption was affected by the amount of family labour. Technology application was affected by the number of neighbours known intimately, education, the amount of family labour, crop area exploited annually and farm gross output factors. The optimization analysis confirmed that there was room to optimize the existing cocoa farmers' practice in the region. Under various constraints of land, labour and crop production, the optimal level of the farm margin may possibly be achieved by making optimal use of the land, introducing a more appropriate application of technology and employing family labour optimally, in both on-farm and off-farm activities.

Factors associated with the farmers' decision making in adopting technology improved our insight into farmers' appreciation of cocoa technology adoption. Farmers adopting technology when cultivating cocoa as a perennial crop were looking towards the long term objective and the long term investment. The average projected return over a number of years will be the most significant farmer objective. However, many other aspects may still contribute to cocoa development. *Firstly*, a comprehensive study of appropriate farming system models under the conditions of the region is needed, including the ecological evidence for promoting cocoa and perennial crops as a sustainable alternative. *Secondly*, the positive implications of technology adoption and application both at farmer's and regional level need to be clarified to determine the optimal benefits. *Thirdly*, a study of integrated cocoa development taking into account all agribusiness aspects is advisable.

4 CONGRESSES

During 1996 staff members of the Department of Agronomy were involved in the organization of several international congresses.

LUCC

From 29 to 31 January 1996 a Land Use and Cover Change (LUCC) Open Science Meeting was held in Amsterdam, The Netherlands. The meeting focused on effects of LUCC on interactions between land and atmosphere, changes in the biogeochemical cycles of the earth and the atmospheric levels of greenhouse gases, and their consequences for sustainable development and human responses to global changes.

The international recognition of the multidisciplinarity and the importance of land use/cover as a research topic has led to the establishment of the land use and cover change (LUCC) core project/research programme by the International Geosphere Biosphere Programme (IGBP) and the International Human Dimensions of Global Environmental Change Programme (IHDP).

The aim of LUCC research is to improve the understanding of the dynamics of land use and land cover change globally, with focus on improving the ability to project such change. An insight into land use and cover change is important to integrated modelling and assessment of environmental issues in general. Therefore, to obtain a firm understanding of global environmental change, insights in land use and cover change are necessary. Moreover, these insights are needed to identify the likely points where human communities can intervene to change the trajectories of global land use (and thereby environmental change) according to changing needs and values. LUCC research can provide information relevant to land use, resource, and environmental policy and planning. LUCC advocates a combination of three different approaches: field-based case studies; thematic assessments of the patterns of land cover change; and regional and global prognostic models of land use/cover.

The LUCC Science Plan, a proposal for the LUCC programme, was presented and discussed at the meeting in Amsterdam, chaired by L.O. Fresco and attended by 153 participants from 34 countries.

In October 1996 the LUCC Core Project Office was opened in Barcelona. Since the Open Science Meeting, several LUCC projects have been initiated and an international research network is emerging.

EAPR

The European Association for Potato Research held its 13th Triennial Conference in Veldhoven, from 14-19 July 1996. There were over 500 participants and over 50 accompanying persons. In addition to the invited plenary papers on environmentally safe and consumer friendly potato production; integrated chain management in potato processing; the agenda for future potato research; the role of CIP in potato research; and the survival of brown rot in cool climates, there were invited keynotes and some 240 offered oral presentations and 140 posters. Special symposia were organized on transgenic biology/gene mapping; soil-borne fungi; mechanical damage; and nematodes.

The plenary papers were well covered by the media and the brown rot issue even made it to the news broadcasts of the national television. The Department of Agronomy was heavily involved in the organization, since it served as the administrative centre of the scientific committee (superbly managed by Dorethé Kuijpers), and provided the secretary of the executive board, and members of the scientific committee and the public relations committee.

ESA

The European Society of Agronomy held its 4th conference in Veldhoven, from 7-11 July 1996. Main themes were agro-ecological characterization, food production and security; integrated and ecological agriculture; and dynamics of nutrients and organic matter. This conference provided the opportunity to highlight the Department's research at different levels of aggregation and on different topics. A large delegation of the department was present and a total of 11 presentations was given.

Staff members were also co-organizing special sessions, delivering keynotes and playing an active role in excursions or other activities.

International Farewell Symposium: Grassland Science in Perspective

On 20 June 1996 an International Farewell Symposium entitled 'Grassland Science in Perspective' was organized in the Aula of the University in Wageningen, The Netherlands by the Department of Agronomy at the occasion of the official leave of professor L. 't Mannetje. Five speakers highlighted aspects of grassland science that had the special attention of Professor 't Mannetje during his professional career: simulation of the dry weight rank method; utilization and losses of nitrogen in grazed grassland; stocking rate and sustainable grazing systems; leguminous forage shrubs for acid soils in the tropics; and the wealth of forage plant species. These contributions have been published as scientific papers in a special volume of the Wageningen Agricultural University Papers (WAUP vol. 96-4), together with the farewell address of Professor 't Mannetje, entitled 'Grassland science, does it exist...?'. This volume can be ordered at the Department of Agronomy (Dfl. 45,-).

KLV

On 12 December 1996 the "Internationale Landbouwdag" (Symposium on international agriculture), organized by the Royal Society of Agricultural Engineers (KLV) was chaired by T.J. Stomph.

5 LIST OF PUBLICATIONS DURING 1996

5.1 PhD theses

Baars, R.M.T., Condition and management of the rangelands in the western province of Zambia. Promotor prof.dr.ir. L. 't Mannetje, Landbouwuniversiteit Wageningen, Wageningen, 1996, 152 pp.

Bussink, D.W., Ammonia volatilization in intensively managed dairy pastures. Promotor prof.dr.ir. L. 't Mannetje, Landbouwuniversiteit Wageningen, Wageningen, 1996, 177 pp.

Dhanapal, G.N., Management of broomrape (*Orobanche cernua*) in tobacco (*Nicotiana tabacum*). Promotors prof.dr.ir. P.C. Struik & prof.dr. M. Udayakumar, co-promotor dr. S.J. ter Borg, Landbouwuniversiteit Wageningen, Wageningen, 1996, 183 pp.

Smit, A.B., PIEteR: a field specific bio-economic production model for decision support in sugar beet growing. Promotors prof.dr.ir. P.C. Struik & prof.dr.ir. J.A. Renkema, co-promotor dr.ir. J.H. van Niejenhuis, Landbouwuniversiteit Wageningen, Wageningen, 1996, 201 pp.

Taher, S., Factors influencing smallholder cocoa production. A management analysis of behavioural decision-making processes of technology adoption and application. Promotors prof.dr.ir. J.A. Renkema & prof.dr.ir. L.O. Fresco, co-promotor dr. P.J.P. Zuurbier, Landbouwuniversiteit Wageningen, Wageningen, 1996, 159 pp.

Tielkes, E.A.C.M., Prélèvement avant maturité des feuilles et des tiges du mil (*Pennisetum glaucum*): l'utilisation comme fourrage et l'effet sur le rendement en grains. Promotors prof.dr. Ch.F. Gall, prof.dr.ir. M. Wessel & prof.dr. S. Schubert, Universität Hohenheim, Stuttgart, Shaker Verlag, Aachen, Germany, 1996, 203 pp.

5.2 Scientific papers

Almekinders, C.J.M., A.S Chilver & H.M. Renia, Current status of the TPS technology in the world. Potato Research 39, 1996, 298-303.

Andriesse, W., P.N. Windmeijer & N. van Duivenbooden, Agro-ecological characterization of inland valleys in West Africa / Caractérisation agro-écologique des bas-fonds en Afrique de l'Ouest. Proceedings of the 1st Annual Workshop of the Inland Valley Consortium, WARDA, Bouaké, Côte d'Ivoire, 1993. Inland valley research in sub-saharan Africa. Priorities for a regional consortium, J.Y. Jamin, W. Andriesse, L. Thiombiano & P.N. Windmeijer (eds.), Inland Valley Consortium, Bouaké, Côte d'Ivoire, 1993, p. 133-146.

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