

## **Vorwort**

Der vorliegende Tagungsband, der in der Schriftenreihe Beihefte zu "Der Tropenlandwirt" als Beiheft Nr. 69 erscheint, ist bereits der sechste Band über Ägypten. Diesmal aus einem anderen Blickwinkel, nämlich dem des Germany-Egypt-Region Inter-Alumni-Net (GEAR). Neu in der Erarbeitung dieses Beiheftes ist die länderübergreifende Kooperation und die Zweisprachigkeit.

Dieses Beiheft wäre ohne finanzielle Unterstützung des Deutschen Akademischen Austauschdienstes (DAAD) nicht zustande gekommen, wofür an dieser Stelle gedankt werden soll.

Unser Dank gebührt auch Frau Prof. Dr. Aref und ihren ägyptischen Kolleginnen und Kollegen, die bei der Organisation des Workshops in Kairo tatkräftig mitgewirkt haben.

Sodann sei auf die gute Zusammenarbeit zwischen den beiden Agrarfakultäten der Universitäten Göttingen und Kassel hingewiesen, die für eine Kooperation mit der Cairo University und mit den Universitäten im ägyptisch-arabischen Sprachraum und das bereits begonnene Alumni-Internet Programm eine gute Ausgangslage darstellt.

Danken möchten wir den Autorinnen und Autoren für ihre Beiträge, die teilweise einen arabischem Abstract beinhalten.

Gedankt sei an dieser Stelle auch Frau Judith Specht für die Formatierung, sowie Herrn Amini und Frau Howe für die Durchsicht, Einleitung und Umschlaggestaltung.

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## Keynotes

### Alumni Activities of the DAAD

A. Stahl

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Section of Alumni programs  
Bonn, Germany

Excellencies, Mr. President, Ladies and Gentlemen, dear Alumni,

it is not only a great honor but also a great pleasure of mine to be able to welcome you on behalf of the German Academic Exchange Service to the international symposium „Sustainable Agricultural and Rural Development in Egypt“.

This is my very first visit to your country and I am very pleased that it coincides with this significant event. I am also very glad that I shall be able to learn more about your country and its splendid and rich culture.

The German Academic Exchange Service or DAAD - as it is called in the english speaking world - is a joint organisation of German institutions of higher education as well as a semi-official organisation of German federal, cultural and academic policy. DAAD supports and promotes the academic exchange of students, graduates and scholars with more than 100 programs. A central element of our activities is the close co-operation with developing countries. We are very proud that in 1998 alone DAAD supported 276 students, graduates and scholars from Egypt.

Recently the Alumni-activities have become more and more important We hold more than 200.000 alumni on our records with aproximately 60 % coming outside from Germany (out of these more than 4200 are from Egypt). However, only a small number are valid addresses.

With a range of different programs DAAD is striving to keep in touch with its former scholarship holders.

Our aims are as follows:

Implementation and support of university-based alumni-activities, pursuing own alumni-projects

Maintaining contact

Contributing to international academic exchange

Building a pool of experience and knowledge (Advise and information to students and scholars)

There are more than 100 associations worldwide of former DAAD fellows and other scholars educated in Germany. They are a „cornerstone“ within the framework of our alumni policy and in the global DAAD network. They ensure that former scholarship holders keep in touch with each other, with German academic institutions and, last but not least, with the DAAD itself.

A close co-operation of German and international institutions of Higher education and DAAD is increasingly becoming more important - especially in an ever shrinking world.

The first long spell spent in a foreign country is a forming experience - so they say. This is a lesson I learned myself and I am sure this applies to many amongst you gathered here as well when you went to Germany in order to study or to do research. The encounter with another country, its people and its culture broadens one's horizon and also creates a deeper understanding of one's own individuality and history. The bonds that are formed often keep throughout an entire life although it is not always easy to keep in contact with friends and colleagues from former students days.

Up until last year most of our programs were restricted to genuine DAAD- fellows. As a consequence, many of those academics who were educated in the Federal Republic without the support of a German institution were left out from DAAD-Alumni activities. Since January 1999, however, a new scheme funded by the Federal Ministry of Economic Co-operation and Development has closed this gap. This program specifically aims to care for those Alumni in developing countries who funded themselves or were financed by their home government as indeed is the case for many amongst you. The overall objective of this initiative is to include those self-funded scholars in the worldwide network of international academic and economic co-operation. For this program it is vital that Alumni get in touch with their host institutions in Germany because applications for this program can only be submitted by them, so as occurred now.

Within the framework of this new program the Universities of Göttingen and Kassel are going to initiate the forming of a regional and specialised network of Egyptian and German universities which will have its foundation and starting-point in this country. The inclusion of Alumni from neighbouring Arab countries is envisaged for the not-too-distant future.

Experts and specialists from various disciplines have gathered here in Cairo to discuss their research projects and findings for sustainable agricultural and rural development. It is the pronounced objective of this conference to found GEAR, "The international Alumni Net - Germany- Egypt and Arab Region" - a very appropriate acronym indeed if you ask me. I think the interest of the Egyptian scholars in this network is impressively demonstrated by the overwhelming number of participants that we can see here today.

Let me take the opportunity to thank all those who contribute to the organisation of this event.

I am very much looking forward to the days to come and I am very pleased to be able to talk about the DAAD- Alumni- programmes at somewhat more length on Monday. I shall be very happy to meet many of you during the course of this conference and to get to know you on an individual level.

I wish you, the participants of this conference, many opportunities for fruitful discussions and every success.

Anke Stahl, DAAD, Bonn, Germany

## Förderung der deutsch-ägyptischen wissenschaftlichen Zusammenarbeit

Alexander Haridi

DAAD

Cairo, Egypt

Exzellenzen, Herr Präsident der Kairo Universität, sehr geehrte Wissenschaftlerinnen und Wissenschaftler,

als der Deutsche Akademische Austauschdienst nach dem Zweiten Weltkrieg wiederentstand, war Kairo – nach London – der zweite Ort, an dem eine Außenstelle eingerichtet wurde. Dies war 1960. Deshalb kann ich Ihnen heute sagen: seit fast vierzig Jahren fördert der DAAD die wissenschaftliche Zusammenarbeit zwischen Deutschland und Ägypten. Ihr Land ist für die deutschen Hochschulen der wichtigste Partner in der arabischen Welt. Kein Land in Nordafrika und dem Mittleren Osten verfügt über mehr Absolventen deutscher Hochschulen als Ägypten. *Masr – Umm at-ta'awun al-ilmi*. Unsere wissenschaftliche Zusammenarbeit hat Tradition, sie ist breit angelegt und berührt alle Bereiche der Wissenschaften, und sie hat Masse: über 4.000 Ägypter sind seit den 60-er Jahren allein vom DAAD gefördert worden. Zusammen genommen ergeben die Kontinuität, die Diversität und die Quantität einen *impact: our scientific co-operation makes a difference*.

Aber der DAAD ist nicht der einzige Akteur auf der Bühne der wissenschaftlichen Zusammenarbeit. Auf der deutschen Seite beteiligen sich auch andere Organisationen an der Förderung von wissenschaftlichen Institutionen und Personen in Ägypten: so z.B. die Deutsche Forschungsgemeinschaft, die Deutsche Stiftung für Entwicklung oder die Alexander-von-Humboldt-Stiftung, um nur einige zu nennen.

Auf der ägyptischen Seite ist es vor allem das Hochschulministerium, und darin die Studienmission, die einer bedeutenden Zahl von ägyptischen Nachwuchswissenschaftlern eine Promotion oder einen Forschungsaufenthalt in Deutschland ermöglicht. In dem Spektrum der verschiedenen Organisationen, die in der wissenschaftlichen Zusammenarbeit unser beider Länder tätig sind, ist die Rolle des DAAD folgende: im tertiären Bildungssektor „High Potentials“ an deutsche Universitäten zu vermitteln, diese Personen inhaltlich und materiell zu betreuen, und nach ihrer Rückkehr nach Ägypten den Kontakt mit ihnen zu halten.

Auf der Gegenseite, d.h. in Richtung *von Deutschland nach Ägypten*, bringen wir deutsche Universitätsangehörige mit geeigneten ägyptischen Partnern zusammen und betreuen sie vor Ort. Die Deutschen kommen als Studenten, als Doktoranden, oder als Lehrende. Und die Erfahrung zeigt, daß die Lehrenden auch immer Lernende sind.

Meine sehr verehrten Damen und Herren, heute ist nur der erste von sechs Tagen, in denen Sie Vorträge hören, diskutieren, und Pläne für die Zukunft schmieden werden. Dazu benötigen Sie ja eine fast schon sportliche Kondition. Deshalb möchte ich Sie nicht schon am ersten Tag mit langen Reden ermüden.

Ich möchte mich heute deshalb auf zwei Fragen konzentrieren:

1. Was hat sich in unserer wissenschaftlichen Zusammenarbeit bewährt, und was kann noch verbessert werden? Und:
2. Welche Herausforderungen erwarten uns in den kommenden Jahren?

Erfolgreich an unserer Zusammenarbeit war und ist:

- die Breitenwirkung: Sie finden Alumni deutscher Hochschulen in Ägypten in allen Fachbereichen, in allen Universitäten, in allen Altersgruppen und in allen Regionen des Landes. Nicht nur in Kairo, sondern auch in Tanta, in Port Said, in Assiut oder Aswan. Sie sind überall.
- In manchen Fakultäten sind unsere Ehemaligen im Lehrkörper so stark präsent, daß man von der Ausbildung einer deutschen wissenschaftlichen Schule sprechen kann. Dies kommt insbesondere in Ihren Disziplinen, also der Landwirtschaft, der Veterinärmedizin, aber auch der Humanmedizin und im Ingenieurwesen vor.
- eine wichtige Eigenschaft unserer Zusammenarbeit ist, daß sie an den Bedürfnissen Ägyptens ausgerichtet ist. Deutschland bietet dem ägyptischen wissenschaftlichen Nachwuchs den Transfer von *know-how* in den Bereichen an, die für die Entwicklung Ägyptens von Bedeutung sind.
- Anders als z.B. die USA es tun, will Deutschland nicht die besten Köpfe abwerben. Die deutsche Politik versucht, den *brain-drain* zu vermeiden. Unser Ziel ist es, durch die Ausbildung von exzellenten Wissenschaftler die eigenen entwicklungs-politischen Anstrengungen Ägyptens zu unterstützen.

Was ist nun weniger erfolgreich in unserer Zusammenarbeit, und was können wir tun, um diese zu verbessern?

Wirklich problematisch ist die unausgeglichene Bilanz unseres Austausches. Um nur die aktuellen Zahlen zu nennen: 1998 hat der DAAD 276 Ägypter in der einen oder anderen Weise gefördert. Im selben Jahr hat die ägyptische Seite nach meiner Zählung sechs (!) deutsche Studenten über die Wafedin-Abteilung unterstützt, mit Stipendien um die 100 DM pro Monat. Eine Betreuung findet in der Regel nicht statt.

Natürlich muß anerkannt werden, daß die Potentiale von Deutschland und Ägypten verschieden sind. Aber es wäre in Ägyptens Kraft, viel mehr Deutsche für erheblich ertragreichere Aufenthalte nach Ägypten zu holen. Deutschland sieht in den ausländischen Stipendiaten potentielle Freunde Deutschlands auf Lebenszeit und Botschafter Deutschlands in der Welt. Könnte Ägypten nicht auch in deutschen Studenten und Wissenschaftlern Freunde und Botschafter Ägyptens sehen? Liegt es nicht im ureigenen Interesse Ägyptens, so viele ausländische Studenten wie möglich an seine Universitäten zu holen?

Bislang allerdings fragt sich Ägypten vor allem: „was kann Deutschland für uns tun?“, und viel seltener: „was können wir für Deutschland tun?“. Aber: nur wenn beide Partner einander Gutes tun, kann man wirklich von „Zusammenarbeit“ sprechen.

Eine weitere Hürde für eine optimale wissenschaftliche Zusammenarbeit zwischen unseren beiden Ländern ist die fehlende Zusammenarbeit zwischen der ägyptischen Studienmission und dem DAAD. Hier ist noch viel Raum für Koordination und Information gegeben.

Und schließlich möchte ich noch die aus meiner Sicht ungenügende Kooperation zwischen den ägyptischen Universitäten selbst benennen. Wie oft ist der Weg von Ägypten nach Deutschland kürzer als der zwischen zwei Institutionen in Kairo? Auf diesem Gebiet könnten noch viele Reibungsverluste abgestellt werden.

Soweit meine kritischen Beobachtungen, die ich mir als Freund und Partner Ägyptens erlaube, mit Ihnen zu teilen.

Sehr geehrte Damen und Herren, die Welt steht nicht still, und seit wir das Wort „Globalisierung“ kennengelernt haben, finden wir, daß sich die Welt noch schneller dreht – in Deutschland wie in Ägypten.

Mit der Wirtschaft und der Kommunikation internationalisiert sich auch die Wissenschaft und zwingt uns zu Veränderungen. Die gesamte Struktur der deutschen Universitätslandschaft ist im Wandel. Die Lehrpläne, die Finanzierung, die Position der Professoren, die Organisation der Hochschule insgesamt stehen zur Disposition. Gleichzeitig ist uns bewußt, daß Bildung und Wissenschaft die Garanten dafür sind, daß unsere Länder im internationalen Wettbewerb als Gewinner, und nicht als Verlierer dastehen. Für Ägypten hat Präsident Mubarak das kürzlich klar ausgedrückt. Technologie und Wissenschaft sind zur nationalen Priorität erklärt.

Ständig entstehen neue, private Universitäten in Ägypten. Sind dies wirklich nur akademische Disneylands für die Kinder der Reichen? Oder werden in einigen Jahren dort die Spitzenergebnisse der ägyptischen Lehre und Forschung erzielt werden?

Nun, für die wissenschaftliche Zusammenarbeit zwischen unseren Ländern möchte ich folgendes voraussagen:

- Die deutschen öffentlichen Mittel für den Austausch werden in den nächsten Jahren nicht weiter wachsen
- Die ägyptischen Privatuniversitäten werden an unserem Austausch beteiligt werden, wodurch der Wettbewerb um das DAAD-Angebot steigen wird
- Deutsche Universitäten werden Ägypter als zahlende Kunden für Bildungsdienstleistungen zu gewinnen suchen
- Die regionale Konkurrenz in den DAAD-Angeboten wird steigen
- Die Privatwirtschaft wird sich stärker engagieren

Sehr geehrte Wissenschaftlerinnen und Wissenschaftler, Sie sind zusammengekommen, um alte Kollegen und vielleicht sogar Lehrer wiederzusehen, und um neue Kollegen kennenzulernen. Ihr gemeinsamer Nenner ist mindestens: daß sie in Deutschland, in Ost oder West, in Nord oder Süd, einen Teil Ihrer Ausbildung erhalten, und einen Teil Ihres Lebens verbracht haben. Oder aus der Sicht unser deutschen Gäste gesehen: daß Sie mit wissenschaftlichen Kollegen aus Ägypten gemeinsam gearbeitet haben und dadurch auch ein wenig über Ägypten erfahren haben.

Sie werden in den nächsten Tagen Gelegenheit haben, sich fachlich auszutauschen, sich unter Ägyptern kennenzulernen, neue Kontakte nach Deutschland zu knüpfen und Pläne für ihre zukünftige Zusammenarbeit zu schmieden. Danken wir der Bundesregierung für die Förderung dieses Vorhabens, unseren DAAD-Kollegen aus dem Alumni-Referat für die Betreuung, vor allem aber den Personen, die sich mit Leib und Seele für das Zustandekommen dieses großartigen Treffens eingesetzt haben:

Frau Dr. Hala Aref, Herr Dr. Mai, Herr Dr. Amini und Frau Ingrid Howe: ich gratuliere Ihnen stellvertretend für Ihre Kollegen zu diesem Internationalen Symposium-cum-Workshop und wünsche Ihnen allen eine erfolgreiche Woche des gemeinsamen Lernens und Zusammenseins.

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## ***Animal Production (Group Scarabaeus)***

### **Breeding strategies for improving animal performance**

E.S. Tawfik\*

#### **Introduction**

The low level of performance of the animal population in the Tropics and Subtropics and the necessity to improve the performance lead to considerations on transferring genes of European and American breeds to the Tropics and Subtropics.

Within the range of this topic the following points are to be discussed:

- Problems of import of high performance animals into the Tropics and Subtropics for pure breeding.
- Possible ways of applying such high performance animals in cross breeding.
- Selection within the local breeds and eventually applying imported breeds from areas of environmental conditions similar to the local conditions and
- The importance of genotype x environment-interactions for determining the breeding programme and the role of research for the decision.

#### **Problems of import of high performance animals in the Tropics and Subtropics for pure breeding**

The possible advantage of applying animals from temperate zones is the intensification of the performance, but it is only possible under optimal environmental conditions. These methods are not only very expensive, but lead to negative results as shown in many experiments. The factors limiting the rearing of animals from temperate zones in the Tropics can be summarised as follows:

- Very little acclimatisation to adverse climate conditions. They have little tolerance of heat as compared to native breeds.
- Their exposure to numerous diseases in the Tropics and Subtropics and
- the high demand of good feeding and rearing conditions.

These environmental factors and the interactions between them lead to the fact that the imported breeds in the Tropics and Tropics do not produce the expected results.

The possibility of keeping pure imported breeds in warm climates is limited to allocation of no infectious diseases and of course where sufficient feeding for these highly efficient animals is available. Even the few good results of high efficiency of temperate breeds in the Tropics have been due to favourable rearing conditions and good management. The results of these experiments are on no account to be applied to indigenous farmers where such favourable conditions are more or less impossible.

Over the last few years there has been intensive farming near the big cities where good marketing conditions are available for animal products. These farms are in the

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position to feed European breeds intensively and obtain good results. These farms produce well but they wholly depend on the import of both animal fodder and the animals themselves. In the light of this, such farms could not be classified under breeding to improve animal husbandry in their area. An example for that is the intensive import of poultry hybrids in many areas. These reasons lead more or less to joint breeding programmes.

### **Possible ways of applying high performance animals in the Tropics and Subtropics in crossbreeding**

The purpose of crossing between high performance animals and the local breeds is to combine the high potential efficiency of the imported animals with the adaptation ability of the local breed to their rough environmental conditions. With the foregoing observations in mind, the next step is to consider some means whereby breeding programmes may be implemented. Recommendations are based on the premise that for any system to be effective some governmental participation and research work will be required - especially in guidance of programmes.

In numerous countries, individual breeders have initiated successful programmes of genetic improvement. They have not, however, been as judicious in consideration of their peers resulting often in dispersion of rather inferior stocks. Individual breeders frequently emphasise traits that may or many not be of the highest economic significance or contribute to the improvement in the general population. Furthermore, for a programme to be effective it should be closely allied to a research programme, which is another important reason for involvement of universities and research institutes.

In order to raise a new population which can adapt itself to the local environment there must be series of crossing procedures with different shares of genes of imported breeds measured on the environmental conditions.

The illustration in Fig. 1 is for grading up local population commonly practised in many tropical areas, frequently with disappointing results. This involves the importation of sires, semen or even groups of males and females, which are employed in a grading up scheme on local stocks. The major disadvantage as normally applied has been the same numbers of animals or semen imported. Nevertheless, this system has met in some places with reasonable success. In this system the local stock is gradually in independence in the environment replaced, but unless the environment is good the first generation cross may be the only group that performs satisfactorily. Disappointing late generations may result in a loss of confidence by villagers - and confidence is a critical feature in livestock improvement. This system should, therefore, be recommended on a broad scale only when managers understand all factors involved.

Fig. 2 illustrates a seemingly more appropriate approach than the previous one for widescale use. In this plan, the government agency initiates the programme by establishing a herd or flock of indigenous females, which are crossed with imported males to produce F<sub>1</sub> males and females. The herd could be carried on either by continuous replenishment of the local type females from the general population or by inter se mating of the crosses coupled with selection. Both methods have advantages. This system is more suitable in many respects than the one in Fig. 1 in that the first generation village animal would contain theoretically only 25 % imported blood and 75% of its native breeding. In subsequent generations, the infusions of imported stock would be





12 and 6%, respectively. Grading up could proceed for 4 to 5 generations before approaching the 50% level. By the time this stage is reached, either the stocks and managers should be good enough to go on with the scheme or the managers should be encouraged to take up some other type of enterprise. This system also has the advantage that if anywhere along the way some of the producers are capable of handling better quality stock, a direct cross can be made with the imported types. It also has flexibility and affords an opportunity to broaden the sampling of combinations of imported and local types.

### **Selection within the local breed**

Although the selection within the local breed is slow, it is however a surer way to improve the animal material. This way has the advantage that because of natural and artificial selection the animals are adapted themselves to the raising conditions in their area.

The importation of breeding material from other tropical or subtropical areas similar to environmental conditions could be a possible method of improving the animals under the condition that there are no specific diseases in the area of breeding. The scheme in Fig. 3 shows an example for the selection within the local breed.

The simplest and least expensive system would be for the government or its agencies to initiate a recording system whereby representatives would go periodically to the village or individual farm and measure milk yield, in the case of dairy production, or weigh calves or lambs as a means of identifying females giving the best performance. The better producing females identified through these records would be earmarked so that their sons would be saved. The sons would be brought to a central location and reared in a common environment, where information could be obtained on rate of growth and development for use in making further selections among the males. Males selected from these groups could then be redistributed for natural service or artificial breeding (AI) for use among the general population of females. This system is illustrated in Fig. 3. The plan shows that the procedure would be repeated periodically, preferably on an annual basis, with the intent of genetic improvement. This would give primary emphasis to the use of superior dams. If used for milk yield in cattle, it would permit up to 33% of the total opportunity for genetic gain (Robertson and Rendel, 1950). In later years the rate of genetic improvement could be enhanced by progeny test information becoming available in the sires distributed in earlier years.

A second system, illustrated in Fig. 4, provides for the establishment of a breeding research institute as a seedstock herd or flock under intensive selection. Selected males could be distributed according to the previous plan for use among the general population. This procedure has often been applied but without very satisfactory results. The inadequacy has resulted from too few animals and too low selection differentials, mainly because the institute confined its base population to an original group of animals chosen principally on a phenotypic basis in one period of the year. The males, and indirectly the females, selected in this rather inefficient fashion have a large influence on later generations. This system could be effective if a selected herd or flock represented the upper 30% of the general population. A more efficient system would be to select a group of animals from the general population and assemble them at the research institute or a commercial farm, where they could be observed through one production cycle - e.g. lactation or lambing.







Following the first „production period“, 50% or more of the females should be discarded. The procedure of female selection should be repeated for several years - at least three and preferably five. The „selected“ herd could be developed as illustrated in Fig. 5. If the selection differential after arrival in the seedstock herd is 50% or higher, the basic group will be of much higher quality than a group produced by one selection period. This is not an expensive procedure as rental or condition of sale could be a part of the arrangements with the initial owners.

The plans described by no means represent all the possibilities. They are set forth to illustrate some possible systems, along with their basic requirements and advantages. Independent of the breeding system there are important points for a successful breeding programme:

- Good co-operation between the breeding centre, the research institute and the farmers.
- Performance control and recording system as a basis for the selection of the breeding animals.
- Continuous systematic selection of the best animals for the breeding.

### **Importance of genotype x environment-interactions for the breeding programme and the role of research for the decision**

In the last illustrations proposing possible ways of production of new breeds show bluntly that the addition of genetic materials is in many ways possible. The question here is whether the relative efficiency of breeding populations in the Tropics and Sub-tropics with different genes` shares of imported breeds remains the same even under different environments. From that point of view it remains to be decided which breeding population fits a particular environment and whether they possess special adaptable capacity for this environment.

Moreover questions of whether special breeding methods should be developed for extreme environmental conditions could be answered through information about the effects of interaction between genotype and environment.

The most important economic characteristics of animals which the breeders try to improve are the quantitative characteristics which generally are modified by environmental influences. The ability of a particular genotype for developing of a character is thus of no pronounced size, but just because of the environmental conditions under which it depends on:

Phenotypic characteristics value = genotypic characteristics value + environmental effect.

$$P = G + U$$

The validity of this equation is to be based on one of the most silent conditions which says:

There is no interaction between genotype and environment, i.e. their effectiveness behaves independently of one another. It is, however, conceivable that the possible reactions of individual genotypes could be interpreted in different ways. This means

that Genotype x Environmental Interaction exists. In the equation an additional changing effect between Genotype and Environment ( $P = G + E + GE$ ). According to Pirchner (1979) there exists Genotype x Environmental Interaction, when the efficiency of a particular genotype in a particular environment does not show any explanation of the average value of both factors but deviate from that expected data.

To clarify a summarised meaning of a genotype x environment relationship in animal breeding, the real changing effects could be limited as illustrated in Fig. 6.

The genotypes could be imported breeds, local breeds or crossbreeds with different genetical shares from the imported and local genes. The environmental conditions could depend on location of the farm, feeding or management even within the Tropics and Subtropics.

In case 1 there is a balanced change of efficiency in the genotype through the bad environmental conditions. Here there is no change in order of sequence of the genotypes and no noticeable change in the variation between the genotypes depending on the environment.

Case 2 shows clearly that a change in environment causes different effects in the genotypes. The genotypes A and B experience a decrease whereas genotypes D and E achieve an increase in valuable efficiency. That leads to a decrease of the genetic variations in the environment (Y) although the order of sequence remains unchanged.

In case 3 change in the order of sequence of the genotypes takes place in which some genotypes improve their order of sequence in the second environment (Y). However, there are others who do not improve but deteriorate. In this case, there is a clear genotype x environment-interaction whereby the variation between the genotypes remains the same.

In the last case, like in case 3, a change in the order of sequence occurs in the genotype, but leads additionally the change in efficiency to a decrease in variation between the genotypes in the environment (Y).

Like the illustration 6 shows the genotype x environment-interaction can be due to two reasons:

1. Populations show variations in different environments.
2. A change in the order of sequence of genotypes occurs in different environments.

Naturally the shifting order of sequence makes difficulties in the practical breeding work. This is very important for the selection of a population for a certain environment or even for the selection of breeding animals within the population.



This means that the order of sequence of sires in an environment is not transferable to other places. Genotype x environment-interaction has an influence on the selection possibilities and has an effect on successful selection in the environment affected.

There are many methods for research into genotype x environment-interaction. The first condition for research is that animals examined for the planned breeding are animals within a population which are surveyed under their environment. For any environment the suitable breeding groups should be sorted.

### **The necessity of examining the availability of genotype x environment-interaction**

There is literature that is available on genotype x environment-interaction for meat and milk production. This examination has mostly to do with intro-origin genotypes (sires within origin) or with environments within the temperate zones.

No unpronounced genotype x environment-interaction has been taken notice of. The environmental conditions under which the genotypes have been examined are not so extreme as in the Tropics and Subtropics.

The genotype x environment-interaction may, however, be clearly expected depending on the difference between the genotypes and environments within the area.

These are no tests about the productivity of different breeds and crosses in the Tropics and Subtropics under different environmental levels. This makes it difficult to determine the suitable population for a certain environment. Here is the important role of the research institutes to find out the suitable breeds to the local environments.

Of interest are the tests of MADSEN and VINTHER (1975) in Thailand (Table 1 and 2) in which they tested many different crossing levels and the effect of different gene shares of *Bos taurus* regarding not only the milk production but the calving interval and the mortality rate. The results showed that under the good management at the Danish-Thai Farming and Training Centre, the increase in milk production was due to the increase in percent of the *Bos taurus*.

The problem of this test was that fertility rate (measured on the calving interval) had a significant effect on the annual milk yield. Cross breeding with high percentage of *Bos taurus* genes showed a high mortality rate, especially between the age of 6 months to maturity (23,7% mortality). Due to these results the breeding of 50% Sindhi/Sahiwal) and 50% Red Danish were considered suitable for the environmental condition in the area.

Unfortunately, there were no comparisons between the crossing methods carried under minimum conditions as shown with native breeding animals. By the judgement of the breeding groups, it must be clear that the crossing between different breeds could have crossing effects which overestimate the genetic efficiency of the F<sub>1</sub> generation. Moreover, each distant generation is reduced to half. This means that a sizeable genetic material would not remain within but lost, a fact that always been neglected.





The genetic ratio between the imported *Bos taurus* breed and each local breed is determined by the environmental conditions. Areas of different production levels (where the climatic effects, the food deficiency and poor management have great effects on productivity on local farms and where the local breeds show specific adaptation properties) enjoy the presence of genotype x environmental interaction to a great extent. In the light of these cases, it can be concluded that a gene transfer for these production conditions is not recommendable.

Data on 2422 and 27756 Friesian cows in Egypt and Germany, respectively, were used to estimate genetic and non-genetic effects on initial milk yield in 70 days (IM), 305-day milk yield (305-dMY), lactation period (LP) and calving interval (I). Data was collected in the period from 1987 to 1992 in Egypt and from 1979 to 1993 in Germany. Least squares analysis shows the significant effect of season and year of calving and parity on all traits.

In Table 3 are the results of the performance of animals in Egypt compared with the data in Germany.

**Table 3: Means, standard deviations (SD) and coefficients of variability (CV) of unadjusted records of traits, initial milk yield (IMY), 305-day milk yield (305-dMY), lactation period (LP), and calving interval (CI) of Friesian cows in Egypt and Germany**

Trait	Egypt			Germany		
	Mean	SD	CV	Mean	SD	CV
IMY, kg	966	319	33	1552	318	21
305 dMY, kg	4736	1097	23	6641	1484	22
LP, day	298	62	21	301	10	3
CI, day	379	72	19	396	58	15

Coefficients of variation computed from residual mean squares divided by the overall least squares means of a given by (Harvey Programme, 1990)  
Numbers of records were 2422 in Egypt and 27756 in Germany

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Table 4 shows the ranking from high to low of certain groups of cattle for characteristics indicative of suitability to a hot environment under either advantageous or disadvantageous management conditions. The results of that test show according to the clear interaction between genotypes and environment the importance of the research to find out the suitable breed for that environment.

**Table 4: Ranking from high to low of certain groups of cattle for characteristics indicative of suitability to hot environment under either advantageous or disadvantageous management conditions, breed groups in the same column with a common superscript (1 or 2) are not significantly different, but do differ from those not having the same superscript ( $P < 0.5$ )**

### Methods of measuring adaptation

Rise in body temperature	growth rate	milk yield
Environment „A“ adequate nutrition, no serious disease problems, good management <sup>A)</sup>		
Zebu	Brown Swiss	Holstein
Zebu-European X	Charolais	Brown Swiss
Santa Gertrudis	Holstein	Jersey
Brown Swiss <sup>1</sup>	Zebu X <sup>1</sup>	Zebu X <sup>1</sup>
Jersey <sup>1</sup>	Santa Gertrudis	Zebu 2
Charolais <sup>1</sup>	Hereford <sup>1</sup>	
Angus <sup>1</sup>	Angus <sup>1</sup>	
Hereford <sup>1</sup>	Jersey <sup>1</sup>	
Holstein <sup>1</sup>	Zebu <sup>1</sup>	
Environment „B“ low nutrition, disease problems, poor management B)		
Zebu	Zebu X	Zebu X
Zebu	Zebu	Jersey
Brown Swiss <sup>1</sup>	Brown Swiss <sup>1</sup>	Brown Swiss <sup>1</sup>
Jersey <sup>1</sup>	Hereford	Holstein <sup>1</sup>
Angus <sup>1</sup>	Charolais <sup>1</sup>	Zebu <sup>2</sup>
Charolais <sup>2</sup>	Holstein <sup>1</sup>	
Holstein	Jersey <sup>1</sup>	
Hereford <sup>2</sup>	Angus <sup>1</sup>	

A) Assumes ample quantity and quality of feed throughout the year, good disease control measures and experienced personnel for management

B) Assumes poor quality feed with serious seasonal fluctuations, little effort made to control disease, and inexperienced personnel

## Summary

1. The use of pure breeds from temperate zones in the Tropics or Subtropics where the environment is severe, seems to be impossible.
2. The use of such imported breeds in a crossing programme with the local breeds is possible in different ways under the consideration of the local environmental factors.
3. The selection within the local breeds is a long but sure way to improve the performances
4. The role of research is very significant to find out the suitable programme for a certain environment
5. Independent of the breeding system there are important points for a successful breeding programme:
  - Good co-operation between the breeding centre, the research institute and the farmers
  - performance control and recording system as a basis for the selection of the breeding animals
  - continuous systematic selection of the best animals for breeding

## Effect of semen extender components on rabbit sperm motility

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### Abstract

Three different rabbit semen extenders based on Tris-egg yolk extender were used in this experiment. To examine the effects of 1% glycerol or 6% dimethylsulfoxide (DMSO) and control (free of glycerol and DMSO) on rabbit sperm motility and acrosomal changes % over a period of three days of storage at 5 °C. Semen samples from White New Zealand (WNZ) bucks were evaluated for initial concentration, pH value and volume in relation to sperm motility and acrosome loss % . The obtained results showed that, there were significant differences ( $p < 0.05$ ) according to extender type used. Where sperm motility % were  $38.0 \pm 4.5$ ,  $47.3 \pm 3.8$ , and  $37.9 \pm 4.1$  % as for control, 1 % glycerol and 6 % DMSO extender, respectively. The correlated studied characters of acrosomal loss % for the same extenders differed significantly ( $p < 0.05$ ) and were  $8.5 \pm 0.63$ ,  $4.5 \pm 0.33$  and  $7.6 \pm 0.68$  % respectively.

**Key Words:** Sperm, Rabbit, Glycerol, Dimethylsulfoxide, *Cryoprotectants*

### Introduction

Many research articles were conducted to study the effects of glycerol addition in rabbit semen extenders on both sperm motility and acrosome integrity (Weitze, 1977 and Weitze *et al.*, 1982). The most popular theory for the beneficial effect of glycerol addition in semen extenders is protection impact of glycerol through salt-buffering mechanism (Lovelock, 1953; Polge and Soltys, 1957). Others reported that glycerol can penetrate sperm cell membrane and concentrate in the posterior part of the sperm head (Pickett and Merilan, 1957).

The recent studies tried to prove that some cryoprotective agents like glycerol have toxic effect on rabbit sperm survival through its content of hydroxyl groups (Hanada and Nagase, 1980). Other authors stated that cryoprotectants containing amides or methyl groups like DMSO have been recommended and used successfully for rabbit sperm preservation (Arriola, 1982; Chen and Foote, 1988).

The objectives of this study were to investigate the effect of cryoprotectants like glycerol and DMSO on rabbit sperm motility and acrosome changes in relation to essential semen characteristics in cooled preserved rabbit semen at 5 °C.

## Materials and Methods

### Bucks and semen collection:

Three New Zealand White (NZW) bucks were used in this experiment with an average body weight 2.5 – 3.5 kg and 12 months of age. The bucks were housed in a wire cages and the doe was transmitted to buck's cage for semen collection. Semen samples were collected by using a glass artificial vagina, supported with a graduated collecting tube and the added water was adjusted on 45 °C at the time of semen collection (Morrel, 1995).

### Semen sample evaluation:

The collected semen samples were put in a water bath adjusted at 38 °C. The samples were subjected to the following examinations: general appearance, sample volume, sperm concentration / ml, pH value and initial motility. Sperm motility was estimated by using a light microscope at 100x magnification on a stage warmed at 38 °C. Semen samples less than 60 % motility were discarded and not included in the experiment.

### Semen extender components:

Tris-egg yolk extender was prepared according to Fischer and Odenkirchen, 1988. Tris-egg yolk extender contained 360 mM Tris, 33.3 mM glucose and 113.7 mM citric acid for control treatment. The second treatment contained 1 % glycerol in the Tris-egg yolk extender. While the third treatment contained 6 % (vol. / vol.) dimethylsulfoxide (DMSO) in Tris-egg yolk extender. For all treatments egg-yolk, penicillin and streptomycin were added to give a final concentration of 5 % (vol. / vol.), 0.01 % (wt / vol.) and 0.05 % (wt / vol.) respectively.

### Semen extension and storage:

The evaluated semen samples were diluted (1 : 5) with three different treatments as mentioned previously at room temperature. The diluted semen samples were put in a closed test tubes (5 ml) in a refrigerator at 5 °C. The storage period of the diluted semen samples was 3 days. To achieve required cooling temperature the tubes were put in a water bath provided with a thermometer to check the required cooling temperature (5 °C) in the water bath every day of the storage period.

### Sperm motility and acrosomal changes assessment:

Initial motility was recorded for both raw collected semen and diluted samples directly after semen collection and during three successive days of storage period at 5 °C by using light microscope with 100x magnification. As for acrosome changes determination, two smeared slides of diluted semen samples were prepared directly after dilution and daily during the storage period. The dried smeared slides were examined directly without staining for acrosomal changes according to Watson and Martin, 1972 by using oil lens of light microscope to obtain 1000x magnification. A total count of one hundred sperm cells was examined for the acrosomal change % for each slide. The average of two slides was recorded for each determination.

### Statistical analysis:

Analysis of variance (ANOVA) was carried out using starting spss/pc program (1993) to study the effects of semen extender ingredients and storage period on both sperm motility % and percentage of acrosomal loss of different semen samples. Correlation was estimated between raw semen characteristics and each of sperm motility % and acrosomal changes % and between sperm motility % and acrosome changes %.



## Results and Discussion

### Sperm motility examination:

Results presented in Table 1 showed that, the sperm motility % was superior and differed significantly ( $P < 0.05$ ) as for Tris-egg yolk extender contained 1 % glycerol which was  $47.4 \pm 3.8$  % for the entire storage period of three days. Whereas, sperm motility % of control treatment (Tris-egg yolk free of glycerol and DMSO) and Tris-egg yolk extender contained 6 % DMSO were  $38.0 \pm 4.5$  and  $37.9 \pm 4.1$  %, respectively for the same storage period. These significant differences may be due to the effect of glycerol in avoiding or controlling cold shock when sperm cells are preserved at 5 °C. It is obvious that rabbit sperm is sensitive and may be died by chilling at temperatures above freezing points as declared by Walton, 1957 and for other animal species by Kumar et al., 1994; Singh et al., 1994; Katila, 1997. The beneficial effect of glycerol which was achieved at this added concentration (1 %) may be associated with the non-toxic effect of glycerol to rabbit sperm especially at this level. The useful effect of glycerol addition was not achieved in the case of DMSO, which can demonstrate the unnecessary to add DMSO alone as a cryoprotective agent in rabbit semen extenders for cooling preservation. Other authors found that cryoprotectants containing amides or methyl groups have been recommended and used successfully for frozen semen (Hanada and Nagase, 1980; Arriola, 1982). Sperm motility percent varied significantly ( $P < 0.05$ ) according to storage period for different treatments (Table 1). The addition of 1 % glycerol in Tris-egg yolk extender maintained sperm motility significantly differed as compared to control or DMSO treatments (Table 1). It is obvious that both of glycerol and DMSO addition maintained sperm motility in a relatively good condition comparing to control treatment during storage period especially glycerol treatment at third day of storage period (Table 1). Also there was a sharp decrease in sperm motility after first day of storage period for all treatments (Table 1) especially control and DMSO treatments. The explanation of this phenomena may be due to high sensitivity of rabbit sperm to face cooling preservation.

### Acrosomal changes assessment:

Studying the acrosomal loss percentage showed that, there were significant differences ( $P < 0.05$ ) among different treatments. The acrosomal changes % were 8.5, 4.5 and 7.6 for control, 1 % glycerol and 6 % DMSO extenders respectively for complete storage period at 5 °C (Table 2). The addition of 1 % glycerol to Tris-egg yolk extender was significantly increased ( $P < 0.05$ ) preservation of acrosomal integrity across storage period as compared to the other treatments during three successive days of cooling as shown in Table 2. There were different stages of acrosomal loss. The observed acrosomal status was recorded to be five different stages as shown in Figure 1. To distinguish between different stages of acrosomal loss, shape No. of sperm cell considered to be intact acrosome for the typical complete or non-changed acrosome, while shapes from No. 2 until No. 5 considered to be acrosomal changes (Fig. 1). There are many changes can occur to sperm cell at acrosomal level during cooling preservation. One of this alterations is the spatial arrangements of the internal structure and outer covering of the cells. Beside a contraction of protoplasm may occur and can happen at different rates depending on the chemical components of the various structures (Slisbury, 1978) including acrosomal structures. The beneficial effect of glycerol at this level in this experiment (1%) may be come from the ability of glycerol to reduce mechanical destructiveness to rabbit sperm cells at acrosomal level.

### Semen samples characteristics:

Values of semen sample evaluation as regard volume, pH value and initial concentration presented in Table 1. There was positive correlation between these characters and sperm motility as shown in Table 3. In addition there were negative relations between sperm motility % and value of pH as shown in Table 3. In addition there was negative relationship between sperm motility and acrosomal changes % especially for first two days of cooling preservation as for glycerol and control treatments as shown in Table 4. But this relation did not persist as for third day of storage where there was a positive relationship between sperm motility and acrosome changes %. These relations may explain the importance of initial semen evaluation for the samples that will process for refrigeration storage.

It could be concluded, that rabbit sperm is sensitive to great extent to cooling preservation. The extenders, which are used, must contain a cryoprotectant agent like glycerol but in a low concentration to avoid toxicity of rabbit sperm (1 % glycerol could be recommended). Also to obtain a moderate rate of rabbit sperm motility, it is useful to store rabbit semen for only one day at 5 °C. Beside, the technique of acrosomal loss % determination using oil lens of light microscope without any kind of staining is a rapid and simple method for assessing acrosomal changes during storage.

Table 2. Mean  $\pm$ SE of sperm acrosomal changes percent of different semen extenders during storage period at 5 °C.

Sample No.	Sperm Acrosomal Loss %											
	Control				Glycerol				DMSO			
	A.D	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup> Day	A.D	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup> Day	A.D	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup> Day
1	3	8	12	12	2	5	5	7	2	5	8	13
2	4	6	10	10	4	3	5	6	4	4	8	12
3	2	7	9	10	2	3	7	8	3	6	9	14
4	4	8	10	11	3	4	4	5	4	5	7	12
5	5	7	11	13	4	3	4	6	4	6	10	11
6	4	8	12	14	2	4	6	7	5	5	9	14
7	6	9	11	13	4	2	5	7	4	6	10	12
Mean	4	8 <sup>A</sup>	11 <sup>D</sup>	12 <sup>G</sup>	3	3 <sup>B</sup>	5 <sup>E</sup>	7 <sup>H</sup>	4	5 <sup>C</sup>	9 <sup>F</sup>	13 <sup>G</sup>
$\pm$ SE	.49	.37	.42	.59	.38	.37	.4	.37	.36	.29	.42	.43
Overall Mean	8.5 <sup>A</sup>				4.5 <sup>B</sup>				7.6 <sup>A</sup>			
$\pm$ SE	0.63				0.33				0.68			

Means with the same letters showed no significant differences using Duncan multiple range test.

Table 3. Correlation among raw semen characters, sperm motility & sperm acrosomal loss%

Correlation	Raw Sperm Conc.			Value of pH			Sample Volume		
1 <sup>st</sup> day sperm motility (Control) (Glycerol) (DMSO)	0.56	0.64	0.63	-0.66	-0.47	-0.7	0.83**	0.66	0.66
2 <sup>nd</sup> day sperm motility (Control) (Glycerol) (DMSO)	0.90**	0.90**	0.77*	-0.68	-0.58	-0.4	0.80*	0.55	0.5
3 <sup>rd</sup> day sperm motility (Control) (Glycerol) (DMSO)	0.91**	0.86**	0.63	-0.46	-0.37	0.0	0.42	0.47	0.0
1 <sup>st</sup> day acrosomal loss (Control) (Glycerol) (DMSO)	0.30	-0.37	0.50	0.34	0.76*	-0.2	-0.25	-0.73	0.2
2 <sup>nd</sup> day sperm motility (Control) (Glycerol) (DMSO)	0.12	0.67	0.67	0.29	-0.37	-0.0	-0.53	0.71	0.4
3 <sup>rd</sup> day sperm motility (Control) (Glycerol) (DMSO)	0.5	0.68	0.55	-0.09	-0.29	-0.0	-0.28	0.63	0.3

\*\*P < 0.01

\* P < 0.05

Table 4. Correlation between sperm motility and acrosomal changes % during storage period.

Correlation	Acrosomal changes %		
1 <sup>st</sup> day sperm motility (Control) (Glycerol) (DMSO)	-0.46	-0.23	-
2 <sup>nd</sup> day sperm motility (Control) (Glycerol) (DMSO)	-0.27		0.78
3 <sup>rd</sup> day sperm motility (Control) (Glycerol) (DMSO)	0.44		0.82**
	0.72		

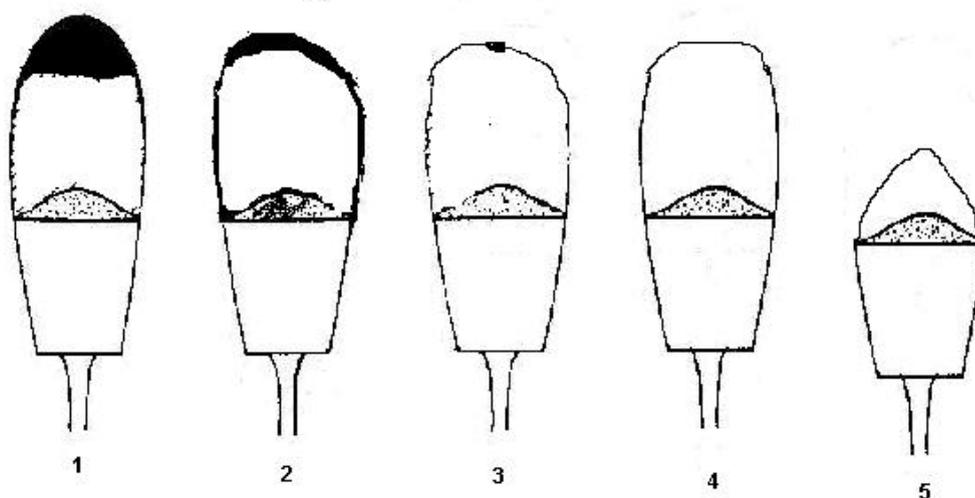


Figure 1. Different stages of acrosomal changes of rabbit sperm during cooling storage. No. 1 considered normal acrosome while No. 2 to No. 5 are changed acrosome when examined by using oil lens of light microscope(1000x magnification).

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## The role of cow's raw milk in transmission of brucellosis

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### Summary

A total of 150 individual samples of blood and raw milk of cows collected from El-Behera Governorate were examined for detection of brucellosis. The samples were tested for SAT. The milk samples were subjected to MRT and isolation of brucella organisms, while the whey was examined for WRBPT and WRiv.T. The results showed that MRT was found to be reliable and sensitive for diagnosis of brucellosis in milk, as it gave positive results in 8 % of samples, as compared with the results of SAT (10%) for serum and WRBPT (4.7%), and WRiv.T (4.0 %) for milk whey. Brucella organism could be recovered from one (0.7%) sample which identified as *Br. melitensis* biovar 3.

The results of experimental study reveal that *Br. melitensis* biovar 3 survived for 8 days in refrigerated raw milk ( $4 \pm 1^\circ\text{C}$ ) and 2 days in raw milk kept at room temperature ( $22 \pm 2^\circ\text{C}$ ). While, it also survived for 12 days in yoghurt cream and 8 days in yoghurt body. The organism cannot withstand pH4.7 in raw milk and 4.2 in yoghurt.

The public health significance, epizootiological importance as well as the necessary measures recommended to control brucellosis were discussed.

## Introduction

Brucellosis is an important milkborne zoonotic disease that it could be, under natural conditions, transmitted from animals to man. This hazard practically spread all over the world, only 17 countries of the whole world have been declared free from animal brucellosis (OIE, 1985). Brucellosis is still reported in some people of these countries, where the disease is usually contracted during travel to endemic areas. The disease in man can be caused by any of the *Brucella* species, *abortus*, *melitensis* or *suis*. The disease due to *Br. melitensis* is more severe and virulent than that caused by the other *Brucella* species.

The infected animals (sheep, goat, cow, buffalo and camel) excrete brucella organisms in their milk sporadically throughout the entire period of lactation in counts varied from a few to up to 15000 cells / ml milk (Robertson, 1961; Sdiwerifeger, 1963; Ismail, 1971; Awad et al., 1975 and El-Gibaly et al., 1981). The brucella content of milk depends on the stage of lactation, as usually, the largest number of brucellae are in the milk at the onset of lactation periods, but both the occurrence and numbers of brucella excreted at any time can vary (Elberg, 1986). Hence, raw milk and its products from infected dairy animals play a significant role in the transmission of the disease to man. It was recorded that two-thirds of brucellosis in human cases at California, USA, arose through consumption of raw dairy products (Wynns, 1944).

Milk ring test (MRT) and blood serological tests are mainly used for diagnosing the disease among cattle. The evaluation of these tests was carried out by many workers (Nicoletti and Muraschi, 1966 and Katz et al., 1976). They stated that neither single milk nor blood serological tests were sufficient to give conclusive diagnosis of positive cases.

Tests for detection of brucella antibodies in milk are considered the principal methods for detecting infected herds and for diagnosing brucellosis in an individual cattle, because it is difficult to recover brucella from infected animals. The ideal diagnostic test for brucellosis should be easy, simple, and rapid test that will detect infected animals as early as possible during the course of the disease. Furthermore, this test should not be influenced by presence of non-specific antibodies arising from other Gram-negative bacteria (Morgan, 1977). Morgan et al. (1978) and Alton et al. (1988) described more specific tests for detecting brucella antibodies in milk such as milk ring test (MRT), whey buffered acidified plate antigen test (WBAPAT), whey rose bengal plate test (WRBPT), whey Rivanol test (WRiv.T), whey ELISA (WELISA) and ELISA milk tests. They were divided classically into screening and confirmatory tests. The screening tests include the MRT, WRBPT and WBAPAT, while the confirmatory tests involve WRiv.T, WELISA and ELISA milk tests.

Therefore, the present work attempts to study the prevalence of brucellosis in cows milk, to select the best screening and confirmatory test or tests suitable for accurate diagnosis of brucellosis, and to study the viability of *Br. melitensis* biovar 3 in raw milk and yoghurt.

## Material and Methods

A total of 150 individual samples of blood and cow's milk of different breeds were collected from different localities in El-Behera Governorate. The milk samples were examined to be free from subclinical mastitis using Schalm test (A.P.H.A., 1985), and lactation period of 1 to 5 months to avoid factors affecting false-positive results of MRT. Each milk sample was divided into two parts, the milk and the milk whey prepared according to Morgan et al. (1978). Each sample was subjected to different diagnostic tests as recorded in the Table.

## Samples and diagnostic tests of brucellosis

Samples	Tests	References
- Serum	- SAT	-Alton and Jones (1967)
- Milk	-MRT -Isolation of brucellae	-Alton et al. (1988) -Alton et al.(1975)
- Whey	-WRBPT -WRiv.T	-Alton et al. (1988) -Nat. Vet. Serv. Lab. (1984)

The titre of MRT, WRBPT and WRiv.T of positive samples of milk and the milk whey were detected using double-serial dilutions of normal milk (non-mastitis, fresh and brucella-free milk), or its whey. Isolation of brucella organisms were carried out by inoculation of albini brucella agar containing antibiotics with the sediment-cream mixture of milk. Simultaneously, enrichment technique using tryptose broth with antibiotics was run parallel. The plates were incubated at 10% carbon dioxide tension. Cultured plates were examined for brucella growth at the 4<sup>th</sup> day and daily up to 14<sup>th</sup> day. Suspected brucella colonies were identified according to Alton et al. (1975).

## Experimental technique

### Preparation of culture

The isolated local field strain of *Br. melitensis* biovar 3, the prevalent biovar among animals and man in Egypt, was used for the experiment. A two-days old culture was suspended in a sterile saline to be used for inoculation of milk and yoghurt.

### Viability of *Br. melitensis* in raw milk

Freshly drawn cow's milk, free from brucella, in a clean and sterile stoppered-bottle was inoculated with the prepared culture of the organism to produce an initial inocula of  $6 \times 10^4$  cells / ml. The control and the inoculated milk were distributed aseptically into two sterile stoppered-bottles (one litre capacity). The first was placed in refrigerator ( $4 \pm 1^\circ\text{C}$ ), while the second was kept at room temperature ( $22 \pm 2^\circ\text{C}$ ). The cream layer as well as milk were examined daily for presence of the organism according to Alton et al. (1975), and pH by using Jeway pH meter.

### Viability of *Br. melitensis* in yoghurt

Two lots of yoghurt were prepared from milk free from brucella organisms for test and control. The milk were inoculated with *Br. melitensis* biovar 3 at  $42^\circ\text{C}$  immediately after the starter to provide an initial inocula of  $6 \times 10^4$  cells / ml. Addition of starter cultures was done according to Lampert (1975). The control and infected yoghurt after being prepared were kept in refrigerator ( $4 \pm 1^\circ\text{C}$ ). Fat layer and curd of yoghurt were examined daily for presence of *Br. melitensis* and pH value.

## Results

Results of the study are presented in Tables 1, 2, 3 & 4

## Discussion

The incidence of brucellosis in dairy animals becomes high with the importation of cattle, this was due in fact to the open door policy where a marked increase in the numbers of intensive breeding farms was recorded following the importation of large numbers of foreign breeds of animals from different countries (Adawy, 1985).

Serological examination of blood serum using SAT showed a higher reactors percentage (10.0 %) than of the milk or milk whey (Table 1). These findings substantiate the results of Alton (1963); El-Gibaly et al. (1990); El-Gibaly et al. (1991) and Hosein and El-Kholy (1993). This result can be attributed to the high sensitivity of this test to detect both IgG and IgM fractions (Salem et al., 1987).

Examination of cow's milk by MRT reveal that 12 (8.0%) of 150 samples gave positive results (Table 1). More or less nearly similar results were recorded by Hamdy (1992), who found 10 % of cow's milk samples were positive. Higher incidence (38%) was recorded by Saaed and Salem (1980), 82.4% by El-Gibaly et al. (1990), 29.2% by El-Sheery (1993) and 66.6% by Hamdy (1997), while lower incidence (4 %) was recorded by Hosein and El-Kholy (1993). The lower reactors detected by MRT, in comparison with blood serological test, may be ascribed to the stage of infection, or to the irregularity in the filtration of the agglutinins from the blood to the milk (Lembke et al., 1950). Moreover, it may be due to the level of the agglutinins in the blood not enough to be excreted in the milk (Pat and Panigahi, 1965).

Boer (1981) considered MRT as unreliable for individual diagnostic test, while other investigators referred to the test as simple, accurate, time saving, highly sensitive, reliable and usefull for detecting brucella agglutinins in milk of individual cows or herds (Ferguson and Robertson, 1954; Nicoletti and Burch, 1969; Morgan et al., 1978; Salem et al., 1987; El-Gibaly et al., 1991 and Hamdy (1992). MRT is known for its sensitivity for IgA (Collin, 1976 and Sutra et al., 1986). It also gave some false-positive cases, as in late lactation period and shortly after parturition, milk from cows with hormonal disorders and those with lower clustering power (Bercovich and Moearman, 1979 and Corbel et al., 1984), which are avoided in this study.

Shifting to the results of the whey agglutination test, it was clear that the over all results revealed low incidence of brucellosis ranging from 4.0 % for WRiv.T to 4.7%. for WRBPT (Table 1). This finding substantiate what have been recorded by Morgan et al. (1978); El-Gibaly (1990) and Hamdy (1997), who found that the whey tests are less sensitive, but less influenced by non-specific factors than MRT. The lower sensitivity of whey tests may be attributed to that the defatting process may deprive milk whey from some immunoglobulins mainly IgA adsorbed to the fat surfaces (Sutra et al., 1986). The removal of the solid parts by rennin, the change in the pH of the whey by the addition of rennet and the changes in molecular weight of immunoglobulins are the other additional factors that may led to low sensitivity of the whey agglutination tests (Sutra et al., 1986 and Hamdy, 1997).

Regarding the sensitivity of the diagnostic tests, results in Table 2 indicate that cows having a high positive serum titres showed positive MRT reaction when their milk diluted up to 1/128 with negative milk, followed by WRBPT (dilution 1/16), and WRiv.T (dilution 1/4). It was also observed that agglutinins titres of milk and whey correspondingly increased with those of blood serum, this may be attributed to the fact that brucella agglutinins in milk originate from the blood stream (Martin and Frank, 1970). These findings are coincident with the results of El-Gibaly et al. (1990); El-Gibaly et al. (1991); Hamdy (1997) and Roepk and Stiles (1970). This result refers to the reliability and sensitivity of MRT in picking up the infected cases than injuring animals for collecting blood serum.

Brucella organisms could be recovered from one (0.7%) milk sample of SAT, MRT, WRBPT and WRiv.T positive, and this isolate was typed as *Br. melitensis* biovar 3, the more prevalent biovar among animals and man in Egypt (Hamdy, 1992). Isolation of *Br. melitensis* from cattle, as non-original host, was firstly recovered in Malta by Shaw (1906), who found that two cows shedding *Br. melitensis* in their milk. Isolation of such organism from cows milk in Egypt was recorded by El-Gibaly (1969); El-Gibaly et al. (1975); Abdel-Aal (1985); El-Sheery (1993); Salem et al. (1987); Hamdy (1989); Hamdy (1992); Hamouda (1989) and Hosein and El-Kholy (1993) by variable incidence ranging from 0.9% to 1.6%. The low rate of recovery of brucella organisms from milk may be ascribed to that these organisms were secreted intermittently in milk (Elberg, 1986).

*Br. melitensis* is endemic in the mediterranean countries. The concept that *Br. melitensis* infects only sheep and goats is nothing, but a hypothesis paradox. When *Br. melitensis* is endemic in sheep and goats, the disease can be easily transmitted to cattle and buffaloes leading to human infection (Verger, 1985). Recovering of *Br. melitensis* from cow's milk represents both epidemiological and zoonotic importance, as such organism is most virulent and pathogenic than other *Brucella* species in man and animals (Elberg, 1986). Moreover, this strain does not lose its pathogenicity in cattle (Ivanov and Kolmakin, 1959 and Hamdy, 1989).

Results presented in Table 3 show that *Br. melitensis* biovar 3 was survived for 8 days in refrigerated raw milk ( $4\pm 1^{\circ}\text{C}$ ) and for 2 days in raw milk kept at room temperature ( $22\pm 2^{\circ}\text{C}$ ). Nearly similar survival periods were recorded by Awad et al. (1975), who found that the organism survived for 5-9 days in raw milk. Also, Hamdy (1992) recorded survival periods of 5 days in refrigerated raw milk and only one day in raw milk kept at room temperature. The difference in survival periods may be due to the bacterial population of raw milk, as well as the initial inocula used in the experiment. The survival periods of such organism in cream layer exceeds those in milk column. This finding run parallel to those recorded by Hamdy (1992). This might be due to that cream is usually more heavily infected than milk, as the organism tend to adhere to the surface of the fat globules forming a complex and the protective effect of the high fat content of cream layer (Champnyz, 1953). The killing effect of milk on the brucella organisms may be due to the acidity developed by the lactic acid bacteria.

Table 4 illustrates the viability of *Br. melitensis* in yoghurt, as the organism was viable longer in fat layer of yoghurt (12 days) than in yoghurt curd (8 days). This may be due to the that the organism tends to be carried up to the top by the fat globules protecting it from yoghurt acidity. Nearely similar results were reported by Hamdy (1992).

Storage temperature obviously affects the survival rate, as brucellae survived longer at refrigerated temperature. These findings are coincident to those obtained by Nour et al. (1975); Abdel-Hakiem et al. (1994) and Hamdy and Abdel-Hakiem (1994). This may be due to the different degrees of acidity developed in raw milk or yoghurt stored at different storage temperatures.

It was found that the pH was determinative for the brucella organisms. When pH reached 4.7 in raw milk and 4.2 in yoghurt, it was impossible to recover *Br. melitensis* (Tables 3 & 4). As the storage period advanced, the acidity percentage increased and consequently affects the survival of the organism. This observation agree with that of Kudaz and Morse (1954); Ghoniem (1972); Hamdy (1992) and Hamdy and Abdel-Hakiem (1994).

It can be concluded that raw milk and its products may be considered a significant vehicle for transmission of brucellosis to man, bearing in mind that *Br. melitensis* is the most virulent biovar to man. MRT proved to be sensitive test and useful in

diagnosing of infected individual cows. As *Br. melitensis* can survived in raw milk and yoghurt, so the prevention of the disease in man depends mainly on the eradication of disease in animals as well as heat-treatment of milk to safeguard the consumers, as effecient pasteurization was enough to destroy brucella organisms in milk.

Table 1: Prevalence of brucellosis according to different diagnostic tests

No. of samples	TAT		MRT		WRBPT		WRiv.T		Culture	
	No.	%	No.	%	No.	%	No.	%	No.	%
150	15	10	12	8.0	7	4.7	6	4.0	1	0.7

Table 2: Sensitivity of diagnostic tests (blood serum, milk and milk whey) of brucella positive samples.

Positive samples	End titre at which positive reaction occurs			
	TAT	MRT	WRBPT	WRiv. T.
1	1/ 80	¼	-	-
2	1/80	½	-	-
3	1/ 320	1/128	1/16	1/4
4	1/320	1/64	1/4	1/2
5	1/160	1/8	-	-
6	1/160	1/16	-	-
7	1/80	1/2	-	-
8	1/80	1/4	-	-
9	1/320	1/64	1/2	-
10	1/80	1/16	-	-
11	1/80	1/2	-	-
12	1/320	1/128	1/8	1/2
13	1/40	-	-	-
14	1/80	-	-	-
15	1/40	-	-	-

Table 3: Survival of *Br. melitensis* biovar 3 in raw milk.

Survival periods (days)	At refrigerator (4 ± 1°C)			At room temperature(22 ± 2°C)		
	Cream layer	Milk column	pH	Cream layer	Milk column	pH
1	+	+	5.9	+	+	5.1
2	+	+	5.6	+	-	4.8
3	+	+	5.5	-	-	-
4	+	+	5.4	-	-	-
5	+	+	5.4	-	-	-
6	+	-	5.3	-	-	-
7	+	-	5.1	-	-	-
8	+	-	4.9	-	-	-
9	-	-	4.7	-	-	-

Table 4: Survival periods (days) of *Br. melitensis* biovar 3 in yoghurt.

	Survival periods (days)											
	1	2	3	4	5	6	7	8	9	10	11	12
Fat layer	+	+	+	+	+	+	+	+	+	+	+	+
Curd	+	+	+	+	+	+	+	+	-	-	-	-
pH	4.7	4.7	4.6	4.6	4.5	4.5	4.5	4.4	4.3	4.2	4.2	4.2

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# **Brucellosis in man and animals in the Middle East Region**

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## **1. Introduction**

Brucellosis remains a serious zoonotic disease in most countries of the region. The disease is reported in animals in all countries of the region, except in Cyprus where it has been eradicated since 1932 in cattle and 1984 in sheep and goats. Most countries of the region depend on importation of animals, particularly cattle both for slaughter and breeding from outside the region. With the intensification of the importation of animals and the establishment of big farms in the last few years, the incidence of brucellosis rose sharply in many countries, both in man and animals. A high incidence rate of brucellosis was reported particularly from several modern commercial dairy farms. The infection was found to be caused by *Br. abortus* in cattle, buffaloes and camels and by *Br. melitensis*, in sheep and goats. The incidence of reactors in those newly established farms of cattle reached in some countries to more than 30%. This alarming situation led to the enforcement of control policy, mostly in the form of test and slaughter policy. The extensive application of S19 vaccination of young females either with the full dose or the reduced dose together with slaughtering of positive animals has resulted in the reduction of the overall reactors rate drastically. On the other hand, brucellosis in sheep and goats, although reported since many years in almost all countries of the region, the incidence is still high and little is done to control the disease. This situation has resulted in the transmission of *Br. melitensis* to cattle, and that is why *Br. melitensis* is now the predominant cause of brucellosis in animals and humans in most countries.

## **2. Situation of brucellosis in animals and man in different countries of the region**

### **2.1. Brucellosis in animals**

2.1.1. In Egypt, brucellosis in animals was reported for the first time in 1939. However, intensive surveillance programmes were initiated after the approval of the National Brucellosis Control Programme in 1981, adopting the test and slaughter policy and vaccination of young female calves with the reduced dose *Br. abortus* S19 vaccine. The average incidence rate of reactors has dropped drastically in 1997 to 0.85% in cattle and 0.3% in buffaloes. In sheep, the incidence is 1.78 and in goats it is 8.17%. Brucellosis has been reported also in camels, swine and dogs. The bacteriological studies revealed the predominancy of *Br. melitensis* biovar 3 in cattle. This organism was isolated also from dogs.

2.1.2. In Libya, brucellosis in animals was reported to be particularly widespread among sheep and goat flocks, especially in the west mountain area and west coastal strip. *Br. melitensis* biovar 1 and 2 were isolated from sheep, goats, cows and camels.

2.1.3. In Tunisia, the year 1991 was the year of explosive outbreaks of brucellosis in sheep and goats. The first outbreak was reported in Gafsa, where the seropositivity reached 61% in goats and 30% in sheep flocks. In positive flocks, 15-20% of females aborted. Outbreaks were reported in 23 governorates. *Br. melitensis* biovar 3 was isolated from infected animals. In bovines, the percentage of herds infected was found to be 13.7%. Surveys carried out in 1992 showed that the percentages of reactors were 1.5%, 4% and 18% in bovines, ovines and caprines, respectively.

2.1.4. In Algeria, the examination of sheep and goats in 1986-1989 revealed an overall seropositivity of 2.18% in sheep and 12.0% in goats. The percentages of infected flocks were however 43.5% and 42% in sheep and goat flocks, respectively.

2.1.5. In Morocco, the overall infection rate among sheep and goats flocks was 14.28%. The highest rate of infection was reported in the central region, followed by the north-eastern region. The percentages of infection in flocks were 15% in 1980-83, 7.4% in 1984-87 and 21.34% in 1988-1991.

2.1.6. In Sudan, brucellosis in cattle, sheep and goats is endemic throughout the country. According to recent surveys prevalence of 14.2% and 16.7% were reported in Khartoum and Central States, respectively.

2.1.7. In Jordan, *Br. melitensis* infection is probably the most serious zoonosis. The first reported focus of infection in goats was identified in 1971 among an imported herd. Between 1971 and 1973, 7% of goats in the country were diagnosed serologically positive. The rate of positive reactors increased continuously so that it reached 22.8% in sheep, 21.0% in goats and 8.7% in cattle. *Br. melitensis* biovar 3 was predominantly isolated from positive animals.

2.1.8. In Israel, *Br. abortus* has been eliminated from dairy and beef herds. *Br. melitensis* represents the major challenge to the livestock industry as it is endemic in cattle, small ruminants and man. The survey of intensive sheep and goat flocks by solid phase ELISA in 1993-95 revealed a reactor rate of 8.2%. In about 10% of the flocks the percentage of reactors ranged between 19 to 37%. The field strain of *Br. melitensis* was isolated from the internal organs and milk, while Rev.1 was isolated only from milk of reactor animals.

2.1.9. In Lebanon, brucellosis in sheep and goats is very frequent. A mini-serological survey done by the Ministry of Agriculture in some private farms showed that almost all of the farms had infected animals. *Br. melitensis* is the main agent of infection in all ruminants. The last screening revealed an incidence of 18% in cattle and 9.2% in sheep and goats. In a last report in 1998, it was mentioned that about 800 cases are reported annually to the Ministry of health.

2.1.10. In Syria, the prevalence of brucellosis in 1988 was reported to be 2.5% in cows and 1.8% in sheep.

2.1.11. In Turkey, a national survey carried out in 1989 estimated the overall rate as 1.26% in sheep and 3.56% in cattle. In 1990 it was 2.08% in sheep and 1.2% in cattle, in 1991 it was 1.83% in sheep and 1.01% in cattle and in 1992 it was 1.48% in sheep and 0.6% in cattle. Data concerning the incidence of brucellosis in the years 1995-97 revealed the occurrence of 7, 5 and 7 outbreaks of *Br. abortus* and 58, 53 and 26 out-

breaks of *Br. melitensis* in the years 1995, 1996 and 1997, respectively. *Br. melitensis* biovar 2 in sheep and *Br. abortus* biovar 3 in cattle were most predominant. Other biovars determined were 1, 2, 4 and 6 for *Br. abortus* and biovar 1 for *Br. melitensis*.

2.1.12. In Iran, the prevalence of brucellosis reached 44% in 1956 and dropped to 5% following control programme that started in 1958. Because of relactancy in control, the reactor rate increased again to 17.4% in 1977. A control programme started again in 1983 with consequent decrease of the prevalence to 1.25% in 1987. In 1991, the prevalence rate was 0.85%. Similarly, the prevalence rate in sheep and goats went up and down. It was 13.7% in 1970, 6.4% in 1980 and 10.18% in 1991.

2.1.13. In Iraq, the disease was reported in sheep (15%) due to *Br. melitensis* and in cattle (3%) due to *Br. abortus*.

2.1.14. In Saudi Arabia, the incidence of brucellosis increased in the years 1986-1988 from 5.7% to 26.0% in sheep and goats and from 0.7% to 7.0% in cattle. During the last 10 years, all *Brucella* species isolated from sheep, goats, cattle and camels were *Br. melitensis* biovar 2.

2.1.15. In Kuwait, the percentages of reactors in cattle increased from 3.0% in 1984 to 5.2% in 1989. In sheep and goats the incidence was 11.1% in 1986 and 6.6% in 1989. In camels, seropositivity rate was reported to be 14.6% in 1985, 14.8% in 1988 and 7.7% in 1989. Serological test done on a flock of sheep in 1993 showed a seropositivity of 9.4%. In 1994, serum samples collected from animals suspected to have brucellosis revealed a positive test in 14% in sheep and 7% in goats. *Br. melitensis* was isolated from sheep, goats and cows.

2.1.16. In Oman, the serological studies undertaken in 1989 showed that the percentages of reactors were 0-8% in camels, 0.3-6.4% in goats and 0.9-3.3% in cattle.

2.1.17. In the United Arab Emirat, a survey done in 1989 revealed an average incidence of 6.4% in goats, 5.4% in sheep, 14.4% in cattle and 1.5% in camels. A survey conducted in 1990 showed prevalence rates of 3.4%, 2.0%, 1.3% and 0.2% in goats, sheep, cattle and camels, respectively.

## 2.2. Brucellosis in man

Although brucellosis is a notifiable disease in some countries of the region, it is often unrecognized and unreported. In many countries, the awareness of medical specialists in relation to brucellosis is very weak and in most of the cases, public health laboratories are not carrying out diagnostic tests. Cases of brucellosis very often remain unrecognized and are treated as other diseases. They are often labeled "Fever of unknown causes". For these reasons, the actual number of cases of brucellosis is unknown and is believed to be far more than the officially reported figures.

The age distribution of reported brucellosis cases from several countries of the region indicates that children are particularly at risk. The incidence has a seasonal pattern with a maximum number of cases during the spring and early summer period.

Infection is transmitted from infected animals by ingestion of raw milk or dairy products, especially cheese made from raw or lightly heated milk. Transmission also occurs through contact with farmers and veterinarians coming in contact with infected animals and frequent infection has been reported in laboratory personnel dealing with

diagnostic works, as in most laboratories, *Brucella* diagnostic is done in the general laboratory and not in a separate one. The incidence of brucellosis in man in different countries according to the available data is as follows:

2.2.1. In Egypt, human brucellosis has received little attention until the WHO strengthened the Zoonosis Centre in Imbaba Fever Hospital in 1990. Before this date only few cases of brucellosis were recorded although the disease is notifiable, e.g. in 1988 only 45 cases were reported. In 1991, a survey was done in 4 governorates with a total population of 6.34 million. The serological examination of 2720 serum samples revealed positive reactors in 10.5% of the samples. The examination of serum samples from 747 cases admitted to the Imbaba Fever Hospital and diagnosed as cases of fever of unknown causes were positive for brucellosis in 323 cases (43.23%). In 1994, 309 cases were confirmed by isolation in Imbaba hospital.

2.2.2. In Libya, brucellosis was diagnosed in man in 150 cases in Nalut Hospital in the mountains area in 1988. In the following year, more than 200 cases were reported out of a population of about 30 000. *Br. melitensis* biovar 2 was isolated from 2 cases.

2.2.3. In Tunisia, the first case of brucellosis was diagnosed in 1909. The official cases of brucellosis were 59 in 1989, 55 in 1990 and 344 in 1991. On October 1991, an explosive outbreak was reported in the southern governorates, particularly in Gafsa, where 407 cases were diagnosed and 85% of the patients had a history of consuming raw milk. The highest rate of infection was registered in May, June and July. The age group mostly affected was 25-34 years, particularly in males.

2.2.4. In Algeria, human brucellosis was discovered as early as 1895 in the Pasteur Institute d' Algeria. Recently, attention has been given to the disease following the serious epidemic reported in 1984 in Ghardaia, where 600 cases were diagnosed. The disease was then reported in other regions. The analysis of data obtained in the years 1988-1990 revealed that the infection rate varied from 0.36-0.67 per 100 000. The highest rate was recorded in May and August which corresponds to the period of parturition and lactation of sheep and goats..

2.2.5. In Morocco, although the first case of human brucellosis was reported in 1916, there no available data on human cases in the recent years.

2.2.6. In Jordan, the infection in man was rarely diagnosed before 1984. During 1984-1985, 69 cases were reported. The number of cases during 1986-1991 in the various districts were 730. 42% of the cases were reported in the capitol region, 9% in Irbid and 7% in the southern regions. On the other hand, the Mafraq area (nomadic) delivered 13% of the cases. 60% of the patients were under the age of 24 years. The peak of infection was in the Spring, which corresponds to the peak of lambing, the maximum production and consumption of fresh cheese products and period of maximum flock movement toward open range.

2.2.7. In Israel, most human cases of brucellosis are reported to be among livestock owners of extensively raised small ruminants.

2.2.8. In Lebanon, human brucellosis is undoubtedly frequent and it occurs throughout the year. During the years 1984-1986, the limited survey done in the country indicates a prevalence rate of 69.6/100 000.

2.2.9. In Syria, human brucellosis is found in most of the provinces. About 220 cases are reported every year, although the estimated number is around 1000. Consumption of fresh cheese is considered the main source of infection.

2.2.10. In Turkey, brucellosis was reported for the first time in 1915. A survey carried out among workers at slaughterhouses in Ankara in 1947 indicated that 10% were infected. Various serological surveys conducted by the Faculty of Medicine in Ankara revealed positive reactor rates between 5.5 and 7%. The largest survey covering different regions of the country was carried out between 1984-1987, where 70 000 serum samples were tested. The prevalence varied between 1.8 - 6%. It was calculated that about 1,75 million person had contracted brucellosis in Turkey. The number of outbreaks increased from 3145 in 1989 (5.48/100 000) to 8383 in 1994 (13.88/100 000). Both *Br. abortus* and *Br. melitensis* were isolated from human cases, but *Br. melitensis* was predominant.

2.2.11. In Iran, human brucellosis is endemic in all parts of the country. Patients recorded in 1988 were 71 051 (132.4/100 000).

2.2.12. In Iraq, the incidence is high in the northern governorates. In 1985, 369 cases (2.3/100 000) and in 1988, 1187 cases (7.2/100 000) were diagnosed.

2.2.13. In Saudi Arabia, the human brucellosis cases increased sharply during the period 1985-1990 from 4.9-69.5/100 000. The highest rate was recorded in 1988 (79.6/100 000). The infection was reported all over the kingdom, but with marked increase at Al-Jouf, Aser and Qasiem. The highest incidence was seen in the Spring and Summer.

2.2.14. In Kuwait, there was an epidemic increase in brucellosis beginning in 1983 with an annual infection rate of 26.8/100 000 which reached its peak in 1985, with a rate of 68.9/100 000. After that the rate began to fall, where it reached 20.1/100 000. Epidemiological investigations of the reported cases have repeatedly confirmed that the traditional habit of drinking raw milk and the consumption of raw dairy products were the main means of transmission. This was especially true among Bedouins where the infection rate among them reached 545.7/100 000.

2.2.15. In Oman, brucellosis is considered, after rabies, the most serious disease. Most of the cases were reported among livestock owners, their families and veterinarians. In 1985, 260 cases were reported, in 1986, 186 cases, in 1987 and 1988 the number increased to 292, in 1989 there were 224 and in 1990 only 184 cases were reported.

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## **A new method of ram frozen semen in form of pellets using the cold surface of cattle fat compared to the conventional methods**

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### **Abstract**

Two extenders were used for semen extension, EYTGFE Vs EYTSFE. Three methods of freezing were used. Straws as a control, pellets using the cold surface of paraffin wax and pellets using the cold surface of cattle fat. Five pooled semen samples showed > 70% motility of spermatozoa. The same extension rate (1:8) and equilibration period (2 hours) were used in the three methods of freezing.

The overall means of post-thaw motility and acrosome integrity of frozen thawed ram spermatozoa using straws, paraffin wax pellets and cattle fat pellets were 49.00, 42.00, & 54.00% and 49.50, 39.20, & 48.30 respectively. The differences between those methods of freezing were highly significant ( $p < 0.01$ ). Freezing of ram semen on the cold surface of cattle fat had a higher and significant differences ( $P < 0.01$ ) in post thaw motility and acrosome integrity compared to that obtained by straws or paraffin wax pellets.

The overall means of post-thaw motility and acrosome integrity were 46.00 & 50.67 and 42.27 & 49.13 for ram semen cryoprotected by glycerol and sucrose respectively. The differences between two types of cryoprotectants were highly significant ( $P < 0.01$ ).

In conclusion, freezing of ram semen as pellets on the cold surface of cattle fat could be used successfully more than straws or paraffin wax pellets. Sucrose (62.50 mM) was used as a cryoprotectant better than glycerol.

**Key words:** Ram Semen, Freezing Methods. Paraffin wax, Cattle fat, Sucrose

### **Introduction**

One of the major limiting factors for the poor fertilizability of frozen-thawed spermatozoa is the reduction of post-thaw motility and viability of spermatozoa. To overcome these problems, it would be suitable to find easy method of freezing to improve the post-thaw sperm characteristics and fertilizability. The best preservation techniques to date of post-thaw survival is restricted to about 50% of the sperm population (Watson and Martin, 1975). The final cryopreservation goal of semen is not only to maintain the initial motility but also to survive in the female reproductive tract at the time of fertilization and to prevent any damage which reduce life span of spermatozoa and its fertilizability.

The cryoprotectant is necessary to reduce or protect the cells from consequences of ice crystal formation and changes in the composition of the medium, as well as the effects of the changes in temperature. Kind and concentration of the cryoprotectant have different results on sperm survival after freezing and thawing. The presence of glycerol lowers the quality of unfrozen as well as frozen semen in some animal species including sheep (Lightfoot and Salamon, 1969). Therefore, a reduction of glycerol content of the extended semen is beneficial for the survival of frozen-

thawed spermatozoa. In addition, the cryoprotective action of glycerol in ram semen is marred by its detrimental effects on post-thaw viability and fertility.

Sugars have the capacity to act as nonpenetrating cryoprotective agents by direct interaction with the membranes. Sugars can prevent membrane damage through not only the extreme dehydration but also lowering temperature transition of phospholipids. These literatures may lead to study sucrose as noncryoprotective agent for freezing ram spermatozoa.

The conventional recommended methods to freeze semen of farm animals are straws using liquid nitrogen vapor and pellets of dry ice. In developing countries such as Egypt, sometimes there is deficiency in straws or dry ice in addition to the expensive cost of these materials. The present work aimed to improve the previous method of pellets using the cold surface of paraffin wax (Awad, 1989). By using the cold surface of cattle fat as a surface of pellets instead of paraffin wax. Also to examine the effect of sucrose as nonpenetrating cryoprotectant compared to glycerol as standard penetrating cryoprotectant on the post-thaw motility and acrosome integrity of ram spermatozoa.

## Materials and Methods

Five different pooled ejaculates of ram semen were collected using the artificial vagina technique at Faculty of Agriculture Farm, Suez Canal University, Ismailia, Egypt. Each ejaculate was immediately evaluated for progressive motility. Three ejaculates of 70 % or more initial progressive motility were pooled together and considered as one sample. Then each pooled semen sample was extended.

Semen Extension: Two extenders were used in this experiment. The first one is Egg-Yolk-Tris-Glycerol-Fructose-Extender (EYTGFE) and the second is Egg-Yolk-Tris-Sucrose-Fructose-Extender (EYTSFE) using two-step to reach 1:8 extension rate. The first step was by adding 4 volumes of diluent A to one volume of the semen sample at 37°C. The second step was addition of 4 volumes of diluent B after 30 minutes of incubation at room temperature. The compositions of diluent A & B of

Both extenders are illustrated in Table 1.

Semen Equilibration: Extended semen samples were kept in a water bath in refrigerator to cool gradually to 5°C within 2 hrs. Then kept at this temperature for another 2 hrs as equilibration period.

Freezing Techniques Three freezing methods were evaluated for motility and acrosome integrity after freezing and thawing. Straws as a control, pellets on the cold surface of paraffin wax and pellets on cold surface of cattle fat as recent pellets methods of freezing. Salamon (1971) technique for freezing ram semen in 0.25-ml straws was used. Awad (1989) technique for freezing ram semen in pellet form on cold surface of paraffin wax was used.

A new technique of pellets on the cold surface of cattle fat was used as the following:

Pellets on the cold surface of cattle fat: Some cattle fat was melted in a bored box of aluminum foil (5 cm high x7cm width x15cm length) to make a layer of 1 cm depth of cattle fat. Some holes were engraved in the surface before left it to reach room temperature. Cattle fat blocks were cooled by immersion in liquid nitrogen for 30 seconds then placed horizontally and lowered into liquid nitrogen vapor 2-3 cm above the surface of liquid nitrogen. About 200  $\mu$ l of semen after equilibration were pipetted into each hole. After 10 minutes on the vapor of liquid nitrogen, pellets were immersed in liquid nitrogen (-196°C), followed by careful packaging into small goblets of appropriate size and transferred into liquid nitrogen storage container.

Thawing of frozen semen: Straws were thawed in a water bath at 37°C for 1 minute, then the surface of each straw was cleaned and dried. Pellets of paraffin wax or cattle fat were thawed by placing the pellets in clean test tube containing 0.2 ml/pellet sodium citrate medium (2.9%) in a water bath at 37°C.

Examination of Frozen Semen Thawed spermatozoa from straws and both methods of pellets were microscopically tested for motility after thawing according to Salamon (1976). However, acrosome integrity after thawing was determined.

Statistical Analysis: Factorial design (3 x 2) was applied to analyze the data by using SPSSWIN (Version 3) computer program. The statistical model was the following:

$$Y_{ij} = \mu + F_i + E_j + FE_{ij} + e_{ij}$$

Such as:  $F_i$ : The effect of freezing method

$E_j$ : The effect extender type

$FE_{ij}$ : Interaction between freezing method and extender type

$e_{ij}$ : Error

## Results and Discussion

Results of this experiment are shown in Table 2 and Figure 1 & 2. The overall means of post-thaw motility and acrosome integrity of frozen thawed spermatozoa using straws, paraffin wax pellets and cattle fat wre pellets 49.00, 42.00, & 54.00% and 49.50, 39.20, & 48.30 respectively. The differences between these methods of freezing were highly significant ( $p < 0.01$ ).

Frozen ram semen in pellets (Lightfoot and Salamon, 1969) and in straws produced lower fertility than fresh semen. Fiser *et al.* (1987) found that the fertility of ewes with frozen thawed semen in 0.5 ml straws or as pellets on dry ice were 73 and 80% respectively, compared to 93% fertility obtained with fresh semen. Ram semen cryopreserved in straws has resulted in fertility higher than that of semen frozen by dry ice pellet procedure. In Egypt, comparison between straws, and pellets frozen on paraffin wax surface, Awad (1989) found that post thaw motility were 37.2 and 33.9 % and conception rates were 50 and 53 % for straws and pellets respectively. However, the fertility of ewes was 73% in case of pellets and 67% in case of straws (Fiser *et al.*, 1987).

The differences between the three method of freezing may be related to cold damage during freezing. These changes may be less in spermatozoa frozen by cattle fat pellets method than that obtained by the other methods of freezing.

Frozen ram semen is used in artificial breeding with acceptable results only for intrauterine insemination, with conception rate of 60-75%. Frozen semen is not suitable for cervical insemination because spermatozoal motility is poor, resulting in low conception rate (25-45%). This limitation of artificial insemination can be overcome by improvement in the freezing procedure. A new procedure of freezing of this experiment using the cold surface of cattle fat is suitable to improve the post-thaw motility and acrosome integrity compared to straws. These results may be improving the freezing technique of farm animals especially ram spermatozoa which have poor results of sperm characteristics and fertility after freezing and thawing.

The poorer performance of pellet semen is explained by some authors. Paquignon (1985) illustrated that the pellets spherical configuration causes uncontrolled temperature variations which leads to disturbance in internal freezing rate and crystallization patterns. On the other hand freezing straws in liquid nitrogen vapor resulted in a constantly changing rate of cooling as the internal temperature decreases (Robbins *et al.*, 1976). These phenomena may cause more damage to sperm cells in paraffin wax pellets compared to those in straws. It seems reasonable that semen

within straws may be cooled uniformly than semen frozen in paraffin wax pellets. In other words, paraffin wax pellets offer less protection to spermatozoa during cooling and freezing because of the direct contact of pellets with the surface of cold paraffin wax. This also causes faster and less gradual changes in deep freezing temperatures in paraffin wax pellets than in straws. Awad (1989) stated that it could be expected that the number of injured spermatozoa by cold damage is higher in paraffin wax pellets than in straws. But the good results of cattle fat pellets in this experiment may be due to lipid molecules which act to protect sperm plasma membrane against cold damage during freezing by reducing the ultrastructural, biochemical and functional damage to a significant proportion of spermatozoa. These changes are usually accompanied by a reduction in motility. This reduction may be minimized during freezing by cattle fat pellets than that obtained by straws or paraffin wax pellets.

These results suggest that the acrosomal membranes of ram spermatozoa were more injured in the straw or in paraffin wax pellets than in cattle fat pellets. The spermatozoa injury described in this study ranged from slight swelling of acrosome to the total removal of the acrosomal sperm membranes.

The poorer characteristics of spermatozoa after freezing and thawing are not only due to freezing method. Frozen spermatozoa may be injured during thawing by rewarming, due to recrystallization of microscopic ice crystal to form larger ice crystals that are widely recognized to be damaging. Abdalla (1983) on goat semen found that the extracellular enzyme contents were significantly increased after freezing and thawing due to the damage of sperm membrane which allowed the intracellular components to go out. He also reported negative correlation coefficient between extracellular enzyme contents and physical characteristics of ram semen. On the other hand, Lindemann et. al. (1982) reported that the dead spermatozoa have a negative toxic effect on the remaining normal sperm population.

The overall means of post-thaw motility and acrosome integrity were 46.00 & 50.67 and 42.27 & 49.13 for ram semen cryoprotected by glycerol and sucrose respectively. The differences between two types of cryoprotectants were highly significant ( $P < 0.01$ ). These results showed that sucrose used as noncryoprotectant is better than glycerol used as penetrating cryoprotectant for both post-thaw motility and acrosome integrity of ram spermatozoa.

Glycerol is one of penetrating cryoprotectant agents that is used successfully to prevent ice crystal formation during freezing bull spermatozoa. To fully prevent ice crystallization, the addition of more than 30% glycerol would be necessary. However, a percentage of 6% glycerol turned out to yield satisfactory cell survival. Glycerol must enter the cell before it can exert its effect and the cell might be injured by the addition or removal of glycerol. Injuries observed are usually attributed to osmotic shock, rather than to chemical toxicity. The presence of glycerol lowers the quality of unfrozen as well as frozen semen in some animal species including sheep (Lightfoot and Salamon, 1969). Therefore, at least a reduction of glycerol concentration of the extender might be beneficial for the survival of frozen semen. The cryoprotective action of glycerol in ram semen is marred by its detrimental effects on post-thaw viability and fertility. Glycerol proved to be a necessary cryoprotective agent in cryopreservation of Boer goat spermatozoa and the optimum concentration was 5%.

Sucrose has the capacity to act as nonpenetrating cryoprotective agents by direct interaction with the membranes. This interaction involves hydrogen bonding of sugar hydroxyl groups with the phosphate groups of membrane phospholipids by replacing the water around the phospholipid head group. Sucrose can also prevent membrane damage caused by extreme dehydration and lower the transition tem-

perature of phospholipids by increasing the head group spacing and thereby decreasing the Van der Waal's interactions between the phospholipid acyl chains.

Generally, disaccharides are more effective in stabilizing bilayer than monosaccharides. Sucrose is the most regularly used protective disaccharides, in some reports to prevent freeze-thaw bilayer destabilization. On the other hand, sucrose yielded higher percentages of intact cells after freezing and thawing than equal amounts of trehalose. Sucrose concentration of 62.5 mM was being superior to 125 mM. The sucrose containing extender was better significantly than the standard extender, which had 6% glycerol for both motility and acrosome integrity after freezing and thawing. These results because sucrose cannot penetrate the cell, the effect is to provide a high external osmotic counterforce to avoid water movement into the cell and because the extracellular fluid does not contain the permeating cryoprotectant, the cryoprotectant is free to diffuse out of the cell.

In conclusion, freezing of ram semen as pellets on the cold surface of cattle fat could be used successfully. Sucrose (62.50 mM) was used as a cryoprotectant better than glycerol.

## Tables and Figures

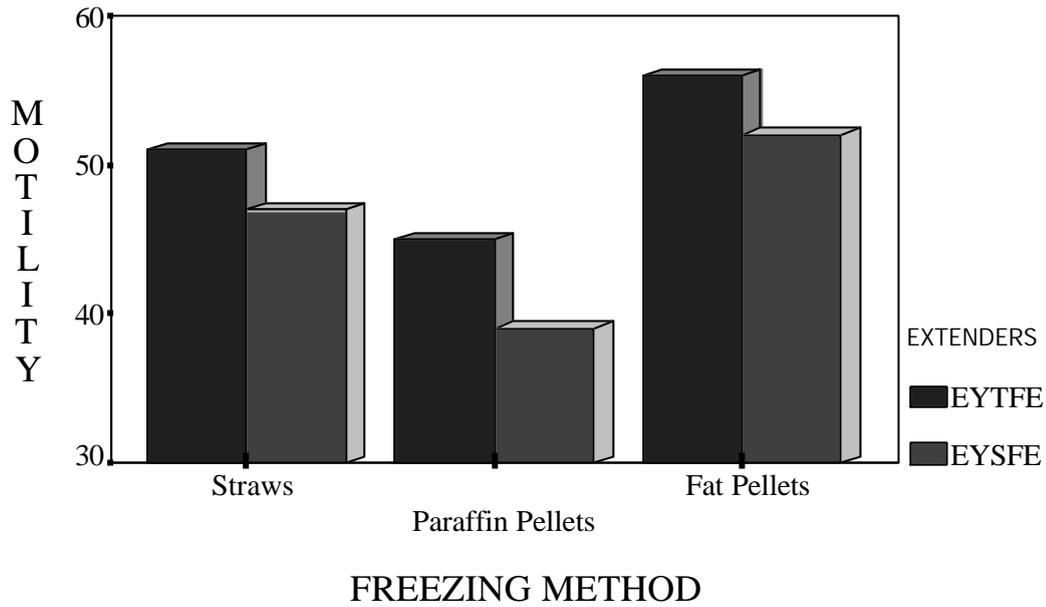
**Table 1:** The components of Egg Yolk-Tris-Fructose-Glycerol (EYTFGE) and Egg-Yolk-Tris-Fructose-Sucrose (EYTFSE) extenders.

Components	Extenders			
	EYTFGE		EYTFSE	
	Diluent A	Diluent B	Diluent A	Diluent B
Tris (g)	3.785	3.785	3.785	3.785
Citric acid (g)	2.115	2.115	2.115	2.115
Fructose(g)	1.00	1.00	1.00	1.00
Sucrose (mM)	----	----	----	125.00
Glycerol (ml)	----	12.00	----	----
Egg yolk (ml)	20.00	20.00	20.00	20.00
Antibiotic (ml)*	1.0 ml	1.0 ml	1.0 ml	1.0 ml
Distilled water	To 100 ml	To 100 ml	To 100 ml	To 100 ml

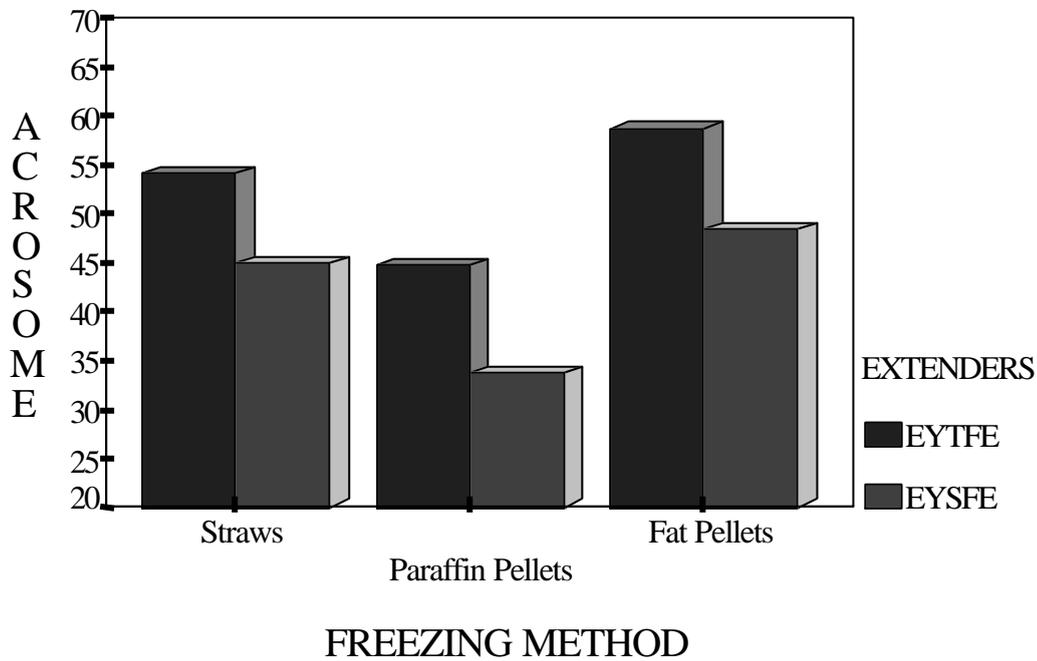
\*Each 1.0 ml of the antibiotic contained 30,000 IU penicillin and 50,000 micrograms streptomycin.

**Table 2:** Means  $\pm$  S.E of post-thaw motility and acrosome integrity of frozen-thawed ram spermatozoa as affected by method of freezing and type of extender.

Freezing Methods	Extenders		Overall Mean
	EYTFE	EYSFE	
<b>Post-Thaw Motility (%)</b>			
Straws	47.00	51.00	<b>49.00</b>
Paraffin Wax Pellets	39.00	45.00	<b>42.00</b>
Cattle Fat Pellets	52.00	56.00	<b>54.00</b>
<b>Overall Mean</b>	<b>46.00</b>	<b>50.67</b>	
<b>Acrosome Integrity After Thawing (%)</b>			
Straws	45.00	54.20	<b>49.50</b>
Paraffin Wax Pellets	33.60	44.80	<b>39.20</b>
Cattle Fat Pellets	48.20	48.40	<b>48.30</b>
<b>Overall Mean</b>	<b>42.27</b>	<b>49.13</b>	



**Figure 1:** Effect of freezing methods and type of cryoprotectant on Post-thaw motility of ram spermatozoa.



**Figure 2:** Effect of freezing methods and type of cryoprotectant on acrosome integrity ram spermatozoa.

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## ***Plant Production (Group Lotus)***

### **Biological measures for the improvement and sustainability of tropical soils**

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#### **Abstract**

The improvement of the food situation in the tropics will depend on reliable production methods adapted to the various conditions of these regions. Besides appropriate technologies for crop management practices, the conservation of soil-biological resources deserve special attention aiming at sustainable soil productivity. The present review emphasizes the importance of the use of the biological properties of the plants such as symbioses and semi-symbioses which substantially improve the exploitation of the macro-nutrients phosphorus and nitrogen in soil for plant nutrition. Thus, enabling a more economic utilization of expensive phosphorus and nitrogen fertilizers specially under the precarious soil conditions in the tropics. The author demonstrates the key role of biological measures under various stress conditions in relation to research activities of the „Institute for Crop and Animal Production in the Tropics“ in Goettingen, and further research needs, with primary emphasis on two distinct tropical environments: the humid and arid/semiarid tropics.

#### **Background**

- Growing malnutrition, i.e., both inadequate and unbalanced nourishment, is the most pressing problem facing the majority of tropical and subtropical countries
- The demand for food is rising all the time as a result of the ever-increasing rate of population growth.
- Estimates by the FAO indicate that in order to maintain even the present level of supply, which everybody knows is insufficient, food production in the tropics will have to increase by at least 60 % in the next 20 years.
- Yet in many areas of the tropics, there are limits on how far this need to intensify agricultural production can be satisfied.
- Because of the growing populations and the resulting shortage of land, many small subsistence farmers can no longer follow the traditional practice of interposing fallow periods of adequate length (6-10 years) in tropical agriculture, such periods play an important role in restoring the humus content and promoting an accumulation of essential plant nutrients.
- The result is a decrease in the natural fertility of the soil, leading to degradation phenomena which are already apparent in agricultural soils in many regions, e.g. the salinity problem in irrigated regions, the acidification of heavy fertilized soils in West Africa, and the accumulation of detrimental residuals of pesticides all over the tropical world.

- In the short run, yields can be boosted through the use of fertilizers, but most small farmers lack the capital required for this approach.
- Because of the unfavourable soil properties, the mineral fertilizers are not well utilized, which means that the desired long-term increase in yield can only be achieved through the continuous application of fertilizer. This is particularly true for those tropical soils which tend to be subject to leaching of the nutrients and phosphate fixation.

Because of these constraints, the farmers are faced with the urgent task of securing their yields by using available local resources; furthermore, the most appropriate strategies to improve and sustain the fertility of the soils, while at the same time ensuring increased production.

Possible solutions which up to now have not been sufficiently researched is the role of biological measures. Particularly the use of useful micro-organisms and organic matter. Although, most of the biological measures have deep roots into ancient centuries, however, their potential is decreasing in the last decades due to intensive fertilization for maximizing the yields.

During the last few years, several research works world-wide have indicated the important role played by soil biology in sustaining the fertility of tropical and subtropical soils. Recently, a large and growing number of international scientists are actively searching for the combination of factors which can be used to describe the soil fertility or soil quality. Soil biology is a cornerstone in developing these indices and yet the understanding of underground biological system is in the early stages of maturity as a scientific discipline.

The biological system present in the soil ranges from the minute to the large mammals, e.g., gophers and moles. One can easily see the effect of large burrowers left by some of the mammals. The effects of the microscopic organisms like bacteria and fungi are less dramatic but they are the key to improving the soil fertility.

## **The role and potential of useful micro-organisms for plant nutrition in tropical and subtropical soils**

The humid- and sub-humid tropics are characterized by climatic factors (near constancy of temperature and humidity) which are responsible for high plant biomass productivity throughout the year. The semiarid and arid tropics are the dry areas of meagre and undependable rainfall, in which the average precipitation often is lower than the potential evapotranspiration. In the semiarid zone the amounts of rain, are, more or less, sufficient for certain types of crops, requesting special management techniques. In arid zones, arable crop production is not possible without irrigation. With the explosive increase in world population, there is increasing pressure on dry lands which constitute fully one-third of land area of the globe.

The arid parts of a great number of countries are now usually vast empty areas. A large proportion is desert, and its contribution to food production is minimal. On the other hand, where water is available (oases) small areas produce a large variety of crops with excellent yields -an indication of the potential of these regions. A limiting factor of irrigated soils in arid areas is salinity which can drastically reduce productivity.

In general, most soils of the tropics and subtropics lacking in significant available nutrients, and phosphorus and nitrogen are considered to be the most deficient plant nutrients. Micro-organisms, the unseen citizens of the soil, control soil productivity by recycling the carbon, nitrogen and other mineral containing compounds in plant and animal residues to form once again available for use by plants. The soil microbiological community also regulates the production and destruction of environmental pollutants and biologically toxic elements and compounds.

In this context some research activities of our institute will be presented to demonstrate the key role of the useful soil micro-organisms in improving the phosphorus and nitrogen supply to plants in tropical and subtropical soils, such as the (vesicular-) arbuscular mycorrhizal fungi ((V)AMF), the phosphate-solubilizing bacteria, the nitrogen-fixing symbiotic, associative and free-living bacteria, and the Azolla/Anabaena-symbiosis in flooded rice.

## **Main fields of research on the use of biological measures at the „Institute for Crop and Animal Production in the Tropics“, Goettingen, Germany**

### **A- Phosphorus nutrition of plants**

#### I- (Vesicular-) arbuscular mycorrhiza, (V)AM

Mycorrhiza is the symbiosis between soil fungi and most higher plants. The (vesicular) arbuscular mycorrhizal fungi ((V)AMF) are obligate symbionts and cannot be propagated in axenic pure culture. The growth-promoting effect of the (V)AM is based primarily on the improved uptake of nutrients, especially of phosphorus by mycorrhizal roots, particularly on poor, marginal and P-fixing soils, which frequently occur in the tropics and subtropics.

A huge number of experiments was carried out under simulated (in the greenhouse) and natural growth conditions of the tropics and subtropics

Eco-physiological studies:

- Great number of species and strains (isolates) of (V)AMF,
- Plant species (approximately 40 tropical and subtropical plant species) and host specificity
- Soil type (acid to alkaline, soil-pH),
- Fertilization with phosphates of different solubility (soluble and hardly soluble phosphates, e.g. rock phosphates),
- Soil temperature,
- Soil water-regime,
- Soil organic matter,
- Soil salinity,
- Soil content of Al and the heavy metals Fe, Mn, Zn, Cu, Pb and Cd, and
- Atmospheric factors: light intensity (= insolation) and day-length (photoperiodism), were investigated.

Mechanisms of P uptake by mycorrhizal plants:

Investigations on „How does the (V)AM improve the P supply to plants?“, the role of organic and chelating acids and phosphatases, and the role and quantification of the external mycelium.

**Taxonomy:**

Isolation, propagation and identification of wide spectrum of species and strains of (V)AM fungi; our institute disposes the greatest collection of these fungi in Europe.

**Practical application:**

Production of inocula and their application techniques. The utilization of (V)AM in monocultures and mixed cropping systems of crops of different families (*Gramineae*, *Leguminosae*, *Solanaceae*, *Compositae* ....).

**Genetic transfer of mycorrhizal efficiency:**

The possibility of transferring the property „efficiency of mycorrhiza to improve plant growth by improving P uptake of mycorrhizal roots“ by cross-breeding between plant varieties of different mycorrhizal efficiencies, and the breeding of nutrient efficient varieties (mainly of wheat and sorghum), to increase the production potential of these plants particularly on poor, marginal and P-fixing soils (calcareous and acid soils of the tropics).

**Contribution of (V)AM to growth of micro-propagated crops:**

Over the past two decades the use of *in vitro* micro-propagation as a technique for the multiplication of several plants has increased rapidly. The main problem of the *in vitro* micro-propagation is the weaning stage for plantlets after the tissue culture. In this stage plants are subjected to severe environmental stress due to poor root, shoot and cuticular formation. This results in an extended weaning stage which is often accompanied by high losses in plantlets and large quantities of chemical inputs in form of fertilizers and pesticides. Several measures such as humidity tents, anti-transpirants, additional light and CO<sub>2</sub> enrichment have all been employed to increase survival rates but with only limited success.

Over the last few years it has been demonstrated that with (V)AM as a biological measure can result in growth enhancement of a wide range of micro-propagated plants especially of those difficult-to-root species. Under natural conditions, plants are normally colonized with (V)AMF and thus are mycorrhizal. In the *in vitro* micro-propagation, (V)AMF, as with all other micro-organisms, are removed. Furthermore, substrates used in the post *in vitro* stages of the micro-propagation technique are normally treated in order to remove potential pathogens which at the same time removes the beneficial (V)AMF. The micro-propagated plantlets will not have the benefits of the symbiosis and only by re-introduction of the (V)AMF will the benefits be acquired.

The savings of energy and chemical inputs due to significantly shorter production cycles and the increases in survival and uniformity of produced plants as a result of inoculation are a major incentive to introduce (V)AM in such techniques, as investigations of our institute have demonstrated with oil palm. Taking these benefits of mycorrhiza into consideration it is likely that in the future inoculation with (V)AMF, will be an integral biological measure of most micro-propagation systems, but a carefully selected and produced (V)AMF inoculum based on relevant research is urgent needed.

**II- Phosphate-solubilizing bacteria:**

The utilization of *Bacillus megaterium* var. *phosphaticum*, *Pseudomonas fluorescens*, *Pseudomonas putida*, *Pseudomonas stutzeri*, and *Citrobacter freundii* alone and combined, or in combination with (V)AMF, was investigated.

## **B- Nitrogen nutrition of plants**

The utilization of the „Biological Nitrogen Fixation, BNF“, by *Rhizobium* and *Bradyrhizobium* bacteria with legumes, and associative and free-living bacteria (*Azospirillum*, *Azotobacter*, *Beijerinckia* and *Derxia*) with gramineous crops (cereals and millets), was tested.

### I- Interactions between N<sub>2</sub>-fixing bacteria, (V)AM mycorrhizal fungi, and phosphate-solubilizing bacteria

The growth and the P and N uptake of several tropical plant species could be improved by the inoculation with various combinations of these effective (useful) microorganisms (EM).

### II- Azolla/Anabaena-Symbiosis in flooded rice

Generally, the most effective source of fixed N<sub>2</sub> is the *Azolla-Anabaena* complex. Known additional benefits derived from *Azolla* intercropping are weed control, water saving and temperature regulation. These benefits were recognized centuries ago by Chinese and Vietnamese farmers.

Integrated soil fertility management is essential if soil productivity is to be improved or sustained. With security in rice production assured through intensification, many scientists, policy makers and farmers are rethinking the long term approach to food security, leading to crop diversification and integrated soil fertility management practices.

The problem is how to integrate the traditional practices of the utilization of *Azolla* fern in wetland rice with modern technologies such as fertilizer use, without losing the benefits of the BNF by this symbiosis.

Information from literature indicates that the *Azolla*-rice systems are capable of increasing by an average of 20%. An additional 20% can be gained by combining *Azolla* (5-6t/ha) with an application of 30 kg/ha of mineral N. The results of our greenhouse experiments showed that *Azolla* is capable of greatly reducing the losses of ammonia through volatilization, which often may reach 30-40% of the applied N (mostly in form of urea), largely by preventing the increase in pH which observed in the absence of *Azolla* as a result of algal activity. This benefit far outweighed any possible competition for the applied N and may be as important as the contribution of N to the soil/plant system from *Azolla* through its symbiosis with *Anabaena*.

## **Conclusions and outlook**

It is increasingly evident that declining soil fertility is the most widespread and dominant limitation on yields and sustainability of cropping systems. Technologies that can be used to sustain soil fertility are still relatively scarce, especially for smallholders. If researchers and farmers do not make a more vigorous attempts to address the extensive decline in soil fertility, the productivity of the farming systems will fail to increase. The following propositions of main criteria should be considered:

- Some general features of the above mentioned biological measures are known, but their role in sustaining soil productivity under stress growth conditions such as those in humid or dry regions has not been studied effectively,
- It is very important to develop improved techniques for propagation of the obligate symbiotic (V)AM fungi and inoculation with introduced highly efficient fungal species and/or strains, and guide-lines for predicting cost effectiveness of inoculation with single or mixed fungi,

- Many kinds of interactions are still unknown in the rhizo-/mycorrhizosphere for different ecosystems. Mycorrhizal fungi are but a part of the microbiological community in the soil and must be considered in this context. Thus, adapted cultivation systems and crop rotations have to be developed concerning legumes, cereals and other non-legumes in sole and mixed cropping,
- For minimizing the inputs in form of chemical fertilization and pest control, maximizing the benefits of inoculations with (V)AM fungi alone or in combinations with other useful soil micro-organisms such as N<sub>2</sub>-fixing bacteria and/or phosphate-solubilizing bacteria (bio-fertilizers) is urgent needed,
- Close co-ordinations between soil biologists/microbiologists, plant breeders, agronomists, soil reclamation specialists, producers and consumers of inocula and extension service stations is of great importance for making full use of the biological measures in practice,
- Biological fertility and sustainability depend by far on soil organic matter which is often used as index of soil fertility; adapted crop rotation help in addition of organic matter in the soil,
- As mentioned above, most of the biological measures have deep roots into ancient centuries, mainly the use of different kinds of organic matter as store and/or resource of most biological components; nowadays the benefits of these measures must be precised and their utilization should be adapted to the biotic and abiotic stress conditions of the tropics and subtropics.

### ***„ Building on the past for a better future“***

The Institute for „Crop and Animal production in the tropics“, in Goettingen, is engaged in several projects for improving the productivity of the poor marginal soils frequently found in the humid and semiarid/arid tropics, by using these biological measures as „bio-fertilizer“ and/or a tool of sustainable agricultural systems.

## Yield of cotton in relation to plant density

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### Introduction

Acid-delinted cottonseed is the highest improved seed quality approaches introduced in Egypt. In 1998, an experiment was carried out on the cultivar Giza 87 to investigate the effect of acid-delinted seed on the plant population and their influence on the productivity of cotton at Sakha, Kafr El-Sheikh, Egypt. The results discovered the plant population could be reduced to 30-40 thousand plants per fed. Without negative effects on yield from unit area in comparison to the traditional growing pattern, that recommend  $60-70 \times 10^3$  plants per fed. Also, the yield of the first harvest was improved.

Such results are not strange, thus the breeding processes and improvement of the modern cultivars with different branching patterns and earliness. In other words the present varieties are different in one or another way from the old ones and need more suitable culture practices, e.g. in terms of planting patterns.

Moreover, the use of high quality acid-delinted cotton seed allows control of pacing facilitates the use of planters or even seed dull for narrow spacing, dressing seed with pesticides and fertilizers and ensure agricultural value of seed. It allows the reduction of the required seed amounts and a lot of funds expended for seed multiplication, contracts, isolation requirements, and processing as well as conditioning. Further more quantities of seed can be saved, as edible oil seed in the country where self produced edible oil is very limited.

Therefore, the present investigation was planned to study the effect of different plant population densities and or planting pattern on cotton yield of the Giza 89 cultivar, under the use of acid-delinted cottonseed. Of the Giza 89 cultivar. This cultivar is spread over two governorates, i.e. El-Monofia and El-Behira.

The obtained information shall provide the basis for further recommendations to improve the quality of cottonseed production under field conditions and to provide information about cotton plant spacing which yield best.

### Material and methods

An experiment was carried out in 1999 season at El-Magd village, Rahmania, El-Behira Governorate. The soil structure is mostly silt and the soil is highly fertile. The preceding crop was Berseem (two cuts) as early winter crop. The soil was operated and  $P_2O_5$  fertilizer in form of monosuperphosphate 15.5% at the rate of 60 kg  $P_2O_5$  feddan incorporated in the soil before ridging and dividing. Also 50 kg Kalium sulfate (24 units and 18 units sulfur) was added.

Three different ridge widths was used, 65 cm, 75 cm and 90 cm widths. Cotton was planted on one ridge-side in hills 20, 75 and 90 cm apart.

Planting date: April 1999:

Planting was done with special instruments prepared for this experiment that allows only unique depth of 3 cm for the seeds.

The seeding rate:

3 different seed-numbers per hill were put. First, the control (Zero) plots on ridges 65 cm wide had to ensure presence of  $64 \times 10^3$  plants per fed and therefore, four seeds were put per hill and the seedlings were thinned to leave two plants per each hill. Second, the hills spaced 25 cm on the 75cm wide ridges and spaced 30 cm on the 90 cm wide ridges contained only 3 seeds. So, the number of seeds in each hill in the last two planting patterns;  $75 \times 25$  cm and  $90 \times 30$  cm; differed, from the control ( $65 \times 20$  cm). Herein, only three seeds were planted in each hill and not more than two plants were left per hill after emergence. Theoretically, the number of plants per feddan within the three planting patterns was  $65 \times 10^5$  ( $60 \times 20$  cm  $\times$  2 plants),  $33.600 \times 10^3$  ( $75 \times 25$  cm  $\times$  1-2 plants) and  $23.333 \times 10^3$  ( $90 \times 30$  cm  $\times$  1-2 plants).

The plants received the same normal growing culture practices.

### Experimental design

The treatments were arranged in a randomized complete block design (RCBD) with four replication. The plot size was  $7 \times 9\text{m}^2$  area in which the plot included the following number of ridges:

14 ridges for the planting pattern ( $65 \times 20$  cm).

12 ridges for the planting pattern ( $75 \times 25$  cm). and

10 ridges for the planting pattern ( $90 \times 30$  cm).

The two outer rows were left as guard rows and:

12 central ridges were used for evaluation of the ( $65 \times 20$  cm) pattern,

10 central ridges, were used for evaluation of the ( $75 \times 25$  cm) pattern.

8 central ridges were used for evaluation of the ( $90 \times 30$  cm) pattern.

The following data were recorded for the field experiment:

- 1- No. germinated hills for ridge seven day after planting counted as an average of all the central ridges.
- 2- No. of germinated hills ridge 11 days after planting counted as an average of all the central ridges.
- 3- No. of plants in each replicate (plot) at harvest and No. of plants per ridge, No. of plants/ $\text{m}^2$ , and number of plants/fed. were calculated.
- 4- No. of fruiting branches (sympdia) per plant in each replication on June 18 (73 days from planting) assessed in 5 guarded hills in each replication.
- 5- No. of fruiting branches (sympdia) per plant on July 30 (115 day from planting) assessed in 5 guarded hills in each replication.
- 6- No. of bolls per hill at harvest counted on 5 guarded hills in each replication.
- 7- Boll weight of first yield, recorded for 10 random open bolls within each replicate in grams.
- 8- Boll weight of second yield, recorded for 10 random open bolls within each replicate in grams.
- 9- Seed cotton yield at first harvest/plot in kg in the guarded ridges of the plot.
- 10- Seed cotton yield at second harvest/plot in kg in the guarded ridges of the plot.
- 11- The total seed cotton yield and yields per  $\text{m}^2$ , per fed. were calculated in ton and in Kenntar (each Kenntar = 157.5 kg)

- 12- Lint percentage first harvest: The percentage of lint produced from a certain weight of seed cotton.
- 13- Lint percentage for second harvest.
- 14- Seed index first harvest: Weight of 100 seeds in first harvest.
- 15- Seed index second harvest: Weight of 100 seeds in second harvest.

## Results and discussion

1- the emergence of the seedlings was not possible after four days from planting under field conditions due to cool temperature during the night. However emergence of most hills was first possible after giving a second irrigation to help the seedling to come out through the soil. The mean number of emerged hills/ridge after 7 days compared to that emerged at 11 days from planting are presented in Tables 1 and 2. The results show the significant higher germinated hills within control (65/20 cm pattern) than that germinated within the 75/25 cm pattern and highly significantly higher than that within the 90 /30 cm pattern. This is naturally a result of experimental scheme.

2- Mean number of plants per plot:

Mean number of plants per plot in Table 3, mean number of plants per ridge (7 m long) in Table 4 and mean number of plants per m<sup>2</sup> in Table 5 show the highly significantly higher number of plants in the control compared to the other two plant population densities, having less population.

Table (1): Means number of germinated hills/ridge *seven* days after sowing of Giza 89 cotton planted by acid-delinted seed.

Planting pattern cm	Plants/hill	Means	Difference
65/20 (control)	2	28.808	-
75/25	1-2	23.083	-5.725*
90/30	1-2	17.713	-11.095**
Mean		23.201	

\*\* = Significant at 1% level.

\* = Significant at 5% level.

Comparison	S.E.D.	LSD (5%)	LSD (1%)
2-P means	1.818	4.448	6.73

Table (2): Means number of germinated hills/ridge *eleven* days after sowing of Giza 89 cotton planted by acid-delinted seed.

Planting pattern cm	Plants/hill	Means	Difference
65/20 (control)	2	31.065	-
75/25	1-2	23.685	-7.380**
90/30	1-2	18.743	-12.323**
Mean		24.498	

\*\* = Significant at 1% level.

Comparison	S.E.D.	LSD (5%)	LSD (1%)
2-P means	1.823	4.461	6.758

Table (3): Means number of plants/plot of Giza 89 cotton *at harvest* planted by acid-delinted seed.

Planting pattern cm	Plants/hill	Means	Difference
65/20 (control)	2	721.875	-
75/25	1-2	343.313	-378.563**
90/30	1-2	279.688	-442.188**
Mean		4.292	

\*\* = Significant at 1% level.

Comparison	S.E.D.	LSD (5%)	LSD (1%)
2-P means	19.804	48.458	73.416

Table (4): Mean number of plants/ridge of Giza 89 cotton *at harvest* planted by acid-delinted seed.

Planting pattern cm	Plants/hill	Means	Difference
65/20 (control)	2	49.753	-
75/25	1-2	29.910	-19.843**
90/30	1-2	27.970	-21.783**
Mean		35.878	

\*\* = Significant at 1% level.

Comparison	S.E.D.	LSD (5%)	LSD (1%)
2-P means	2.095	5.127	7.767

Table (5): Mean number of plants/m<sup>2</sup> of Giza 89 cotton *at harvest* planted by acid-delinted seed.

Planting pattern cm	Plants/hill	Means	Difference
65/20 (control)	2	10.933	-
75/25	1-2	5.695	-5.238**
90/30	1-2	4.445	-6.488**
Mean		7.024	

\*\* = Significant at 1% level.

### 3- Number of fruiting branches (sympdia):

The fruiting sympdia carry the squares, flowers and bolls of cotton plant as the generative organs of the plant. In the study, this character was assessed and recorded at begin of the flowering season and at the end of the productive flowering season on guarded random plants. This parameter is of most importance because it is related to the capacity of the plant to develop the best yield of cotton, thus the flowers produced during this period give bolls that can develop-grow and mature to opening during the most suitable growing season. The later produced flowers (after July) produce bolls that are mostly smaller in size and do open producing immature fibers as well as immature seeds and a lot of mites and mostly infested with boll- worms.

The results shown in Table 11 and 13 disclosed that the cotton plants produced more sympdia under spacing in terms of wider ridges and, wider spacing among hills compared to the control. Also, the number of sympdia increased in a linear way as the plant population was decreased. So, cotton plant is a plant that can do nice compensation in its productivity. Such results are very clear to observe 73 days and 115 day from planting. Tables 6 and 7 show that the number of sympdia was increased linearly by reducing the plant population and the linearity become more obvious on July 30

where the relative increase in mean number of fruiting symposia was strongly increased as the spacing was widened from 65 × 20 cm, 75 × 25 cm to 90 × 30 cm with highly significant differences according to the DMRT as well as LSD comparisons.

Table(6): Mean number of fruiting branches/plant on *June 18 (73 days from planting)* of Giza 89 cotton planted by acid-delinted seed.

Planting pattern cm	Plants/hill	Means	Difference
65/20 (control)	2	9.215	-
75/25	1-2	11.690	2.475*
90/30	1-2	13.280	4.065**
Mean		11.395	

\*\* = Significant at 1% level.

Comparison	S.E.D.	LSD (5%)	LSD (1%)
2-P means	0.771	1.886	2.857

Table (7): Mean number of fruiting branches/plant on *July 30 (115 days from planting)* of Giza 89 cotton planted by acid-delinted seed.

Planting pattern cm	Plants/hill	Means	Difference
65/20 (control)	2	15.418	-
75/25	1-2	21.083	5.665**
90/30	1-2	25.723	10.305**
Mean		20.741	

\*\* = Significant at 1% level.

Comparison	S.E.D.	LSD (5%)	LSD (1%)
2-P means	1.257	3.075	4.659

#### 4- Number of bolls per hill :

At harvest, when the total number of bolls per hill was counted on 20 guarded hills; 5 plants from each replication. This was done at harvest to avoid the effect of shedding of young bolls during development. The mean number of bolls/hill at harvest is presented in Table 8. It indicates that the number of bolls was highly significantly increased under less plant population, compared to the control treatment (the old recommended plant spacing). However, both suggested 75 × 25 cm and 90 × 30 cm plant spacing patterns produced highest bolls number and did not differ from each other, even they had only one plant in more than 50% of its hills. This result indicates again that one can produce enough cotton bolls per plant by wise and rational less plant population.

Table (8): Mean number of bolls/hill at harvest of Giza 89 cotton planted by acid-delinted seed.

Planting pattern cm	Plants/hill	Means	Difference
65/20 (control)	2	56.250	-
75/25	1-2	75.500	19.250**
90/30	1-2	74.250	18.000**
Mean		68.667	

\*\* = Significant at 1% level.

Comparison	S.E.D.	LSD (5%)	LSD (1%)
2-P means	2.424	5.931	8.985

#### 5- Boll weight of first harvested yield (g):

The plant growth in the experimental location reached nice growth and under such high fertile soil condition (beside the Nile coast), the boll weight of the cultivar Giza 89 reached wonderful weight for Egyptian cotton (*Gossypium barbadense* L.). However, the differences in mean boll weight were not statistically significant (See Tables 9 and 10). This character, boll weight of the first yield was negatively influenced by the vigorous growth of the plants, where shading and the high humid microclimate among the plant bases, caused *Fusarium* infection and shedding (drop) of young bolls. Such early lower plant part fruits had to add more yield and bigger first harvest bolls of high yield and high lint as well as seed quality. Such conditions were partially controlled through the reduction of the nitrogen fertilizer level and increase of the phosphorous fertilizer.

Table (9): Mean boll weight g at first harvest of Giza 89 cotton planted by acid-delinted seed.

Planting pattern cm	Plants/hill	Means	Difference
65/20 (control)	2	3.605	-
75/25	1-2	3.271	-0.334 ns
90/30	1-2	3.443	-0.162 ns
Mean		3.439	

\*\* = Significant at 1% level.

Comparison	S.E.D.	LSD (5%)	LSD (1%)
2-P means	0.161	0.394	0.597

#### 6- Boll weight of the second harvested yield (g):

This character was similar in response to that of the first harvest yield. However, the size of bolls was some what smaller and therefore, lighter in weight compared to that of the first harvested yield (see Tables 11 and 12).

Table (10): Mean boll weight g at second harvest of Giza 89 cotton planted by acid-delinted seed.

Planting pattern cm	Plants/hill	Means	Difference
65/20 (control)	2	2.908	-
75/25	1-2	2.678	-0.229 ns
90/30	1-2	2.924	0.016 ns
Mean		2.837	

ns = not significant.

Comparison	S.E.D.	LSD (5%)	LSD (1%)
2-P means	0.105	0.258	0.391

The analysis of variance showed highly significant treatment, significant harvest time mean squares, significant population mean squares and highly significant harvest × population interaction mean squares.

Within all the patterns the first harvest had highly significant increase in boll weight than the second harvest. The pattern 75 × 25 cm × 1-2 plants produced, smaller boll weight compared to the other two patterns. However, this result is mainly due to the differences in the first harvest. But, the general mean of boll weight in the first harvest was highly significantly higher than that of the second harvest.

Table (11): Mean boll weight (g) in 1<sup>st</sup> harvest compared to 2<sup>nd</sup> harvest of Giza 89 cotton planted by acid-delinted seed in 1999.

Planting pattern cm	Plants/hill	Harvest (H)		Means (p)	Difference
		1 <sup>st</sup>	2 <sup>nd</sup>		
65/20 (control)	2	3.605 a	2.908 a	3.256 a	0.697 **
75/25	1-2	3.300 b	2.678 a	2.989 b	0.622 **
90/30	1-2	3.368 ab	2.924 a	3.146 ab	0.443 **
Mean		3.424	2.837	3.130	0.587 **

\*\* = significant at 1% level.

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

Comparison	S.E.D.	LSD (5%)	LSD (1%)
2-H*P means	0.122	0.259	0.358
2-p means	0.086	0.183	0.253
2-H means	0.070	0.150	0.207

#### 6- Cotton Yield:

Seed cotton and lint yields are the end products of the plant as raw yield. All the research work can develop the plant characteristics as desired in quality but the yield per unit of land and unit of water should not be reduced. Also, the cultural packages for cotton production can require high investment of land, seed, plant protection, labor, irrigation... etc., but the yield must be enough to cover the costs and satisfy the cotton gr, even, if the selling price is world over controlled.

The reduction of plant population permits the use of minimized seed rate. This can save a lot o,as high quality acid-delinted seed is not expensive and the farmer should pay all its real costs.

In the present study, two plant populations were suggested in comparison to the normal population. The data in table 13 show that the seed cotton yield/plot was not reduced by use of lower plant populations, but it was somewhat higher than that of the recommended control. However, the differences were not enough high to reach the significance level..

In our study, yield was harvested twice. Data in Table 12 show also, that the first yield of the plant densities 75/25 cm and 90/30 cm were not significantly different from that of the traditional control, however they exhibit, a trend to produce higher yields.

Table (12): Mean total seed cotton yield/plot kg of Giza 89 cotton planted by acid-delinted seed.

Planting pattern cm	Plants/hill	Means	Difference
65/20 (control)	2	15.340	-
75/25	1-2	16.783	1.443 ns
90/30	1-2	15.990	0.650 ns
Mean		16.038	

ns = not significant.

Comparison	S.E.D.	LSD (5%)	LSD (1%)
2-P means	0.650	1.591	2.411

Table (13): Mean seed cotton yield/plot kg at first harvest of Giza 89 cotton planted by acid-delinted seed.

Planting pattern cm	Plants/hill	Means	Difference
65/20 (control)	2	9.883	-
75/25	1-2	10.610	0.727 ns
90/30	1-2	10.288	0.405 ns
Mean		10.260	

ns = not significant.

Comparison	S.E.D.	LSD (5%)	LSD (1%)
2-P means	1.037	2.537	3.843

Similar results were also obtained for the second harvest. However, the yield of the first harvest was almost two times that of the second harvest. (Tables 13 and 14).

Table (14): Mean seed cotton yield/plot kg at second harvest of Giza 89 cotton planted by acid-delinted seed.

Planting pattern cm	Plants/hill	Means	Difference
65/20 (control)	2	5.688	-
75/25	1-2	6.198	0.510 ns
90/30	1-2	5.703	0.015 ns
Mean		5.863	

ns = not significant.

Comparison	S.E.D.	LSD (5%)	LSD (1%)
2-P means	0.573	1.402	2.124

When the total seed cotton yield was adjusted to international area units, the yield comparisons per square meter are presented in Table 15 and that per hectare are presented in Tables 1. Thus, the reasonable and rational low plant population around 30 thousand plants per fed. can produce the same or better yield than the higher populations.

Table (15): Mean total seed cotton yield/m<sup>2</sup> g of Giza 89 cotton planted by acid-delinted seed.

Planting pattern cm	Plants/hill	Means	Difference
65/20 (control)	2	0.291	-
75/25	1-2	0.318	0.028 ns
90/30	1-2	0.317	0.026 ns
Mean		0.309	

ns = not significant.

Comparison	S.E.D.	LSD (5%)	LSD (1%)
2-P means	0.013	0.032	0.049

Table (16): Mean total seed cotton yield/fed. *ton* of Giza 89 cotton planted by acid-delinted seed.

Planting pattern cm	Plants/hill	Means	Difference
65/20 (control)	2	1.247	-
75/25	1-2	1.347	0.100 ns
90/30	1-2	1.332	0.085 ns
Mean		1.309	

ns = not significant.

Comparison	S.E.D.	LSD (5%)	LSD (1%)
2-P means	0.053	0.130	0.190

#### 8- Seed Index :

The seed index data (Table 17) showed that the plant populations used herein did not effect the seed index strongly. But, this trait was strongly affected by the harvest time. The seeds produced from the first harvest were higher in weight than that of the second harvest. This means, that second harvest produce low quality seeds, that are not suitable for cultivation.

The differences in seed index between the two harvests were highly significant.

Table (17): Mean seed index (g) of Giza 89 cotton planted with acid-delinted seed in 1999.

Planting pattern cm	Plants/hill	Harvest (H)		Means (p)	Difference
		1 <sup>st</sup>	2 <sup>nd</sup>		
65/20 (control)	2	9.058 a	11.265 a	10.162 a	-2.208**
75/25	1-2	8.912 a	11.308 a	10.110 a	-2.396**
90/30	1-2	9.187 a	11.261 a	10.224 a	-2.074**
Mean		9.052	11.278	10.165	-2.226**

\*\* = Significant at 1% level.

ns = not significant.

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

Comparison	S.E.D.	LSD (5%)	LSD (1%)
2-H*P means	0.258	0.550	0.761
2-p means	0.149	0.318	0.439

#### 9- Lint percentage:

The lint percentage of the first harvest was highly significantly lower than that of the second harvest (Table 18). This is mainly caused due to the high seed index in the first harvest compared to that of the second one. However, these differences were only significant in both 65/20 cm (the control treatment) and 75/25 cm plant population patterns. But, the difference was highly significant in the 90/30 cm plant population pattern that produced high seed index besides its higher yields than the control in the first harvest.

Table (18): Mean lint percentage of Giza 89 cotton planted by acid-delinted seed in 1999.

Planting pattern cm	Plants/hill	Harvest (H)		Means (p)	Difference
		1 <sup>st</sup>	2 <sup>nd</sup>		
65/20 (control)	2	0.362 a	0.396 a	0.379 a	-0.034 *
75/25	1-2	0.370 a	0.404 a	0.387 a	-0.034 *
90/30	1-2	0.358 a	0.399 a	0.378 a	-0.041 **
Mean		0.363	0.400	0.381	-0.036 **

\*\* = Significant at 1% level.

ns = not significant.

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

Comparison	S.E.D.	LSD (5%)	LSD (1%)
2-H*P means	0.013	0.029	0.039
2-H means	0.008	0.016	0.023

## Conclusions

It can be concluded from the above results that:

It is possible to reduce the amount of needed seed to plant the unit area *fed*. With *less than twenty kg* of the acid-delinted cottonseed. However, it needs intensive extension and close activity with the farmers.

The results are very promising to reduce the plant population and get good yield and quality.

Our experience this year showed that special care should be given to the first irrigation. Thus, the heavy irrigation is not required, but wide ridges in case of low plant population water should go through the ridge mass to help enough germination.

The results should be ascertained by another experiment.

The back history of the soil fertility or/and soil analysis to have idea about the soil fertility, structure, drainage and requirements of fertilizers are important behind the preceding crop.

The farmers around our experiment and not only in adjacent fields were highly satisfied by our experiment and many of them like to go with lower plant populations and follow our practices.

## **Socio Economics (Group Sphinx)**

### **Von nachholender zu nachhaltiger Entwicklung?**

#### **Zur Auseinandersetzung mit der Forderung nach Solidarität mit der Umwelt, Mitwelt und Nachwelt**

Diethard Mai<sup>1</sup>

#### **Ausgangslage**

In großen Teilen der Welt ist weiterhin die Befriedigung der Grundbedürfnisse für ein menschenwürdiges Leben ungesichert. Es gibt es mehr als eine Milliarde Menschen, die mangel- oder fehlernährt sind oder nur einen unzureichenden Zugang zu Gesundheitsvorsorge und Bildungsmöglichkeiten besitzen.

Das Einkommensgefälle zwischen westlichen Industrieländern und der Mehrzahl sog. Entwicklungsländer wie auch der Staaten in Ost- und Mitteleuropa hat sich vergrößert. Das reichste Fünftel der Weltbevölkerung verfügt inzwischen über das 150-fache des Einkommens des ärmsten Fünftels. Zunehmende Einkommensunterschiede innerhalb einzelner Regionen und Länder sind festzustellen.

Weitgehend positiv verläuft dagegen seit Beginn der 90er Jahre die Entwicklung bei sozialen und politischen Menschenrechten.

Die Weltbevölkerung ist um die Jahrhundertwende auf über sechs Milliarden Menschen angewachsen. Die Zunahme hat sich vor allem in den Ländern des Südens vollzogen.

Das Gefälle zwischen Wohlstands- und Armutsregionen hat den Migrationsdruck von Süden nach Norden und von Osten nach Westen erhöht. Millionen von Menschen sind durch soziales Elend, politische Unterdrückung, Umweltkatastrophen und Kriege entwurzelt und z.T. auf der Flucht.

Die Industrieländer dominieren weiterhin die Weltwirtschaft, wobei die Wachstumsdynamik regional sehr unterschiedlich ausfällt. Nach Wegfall des Ost-West-Konflikts scheinen der weiteren Ausbreitung der Marktwirtschaft kaum noch Grenzen gesetzt.

Allerdings wächst die Schadstoffbelastung in der Atmosphäre. Die existentiellen menschlichen Ressourcen - Boden, Wasser und Wald - sind in gefährdet. Der Energieumsatz ist zwischen 1970 und 1990 weltweit um rund die Hälfte gewachsen.<sup>2</sup>

Die Verwirklichung einer dauerhaften, ökologisch verträglichen und sozial ausgewogenen Entwicklung bleibt somit weiterhin die größte Herausforderung der Menschheit.<sup>3</sup>

#### **Entwicklung und nachholende Entwicklung**

Als das Wort „Entwicklung“ 1645 zum ersten Mal gedruckt wurde, meinte es mechanisches „Auswickeln“, etwa einer Schrift- oder Garnrolle. Im frühen 18. Jahrhundert fand es im Pflanzenbereich Anwendung, z.B. bezogen auf die Entwicklung der Knospe aus

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<sup>2</sup> Vgl. hierzu Hauchler, I./Stiftung Entwicklung und Frieden (Hrsg.), (1993). Globale Trends 93/94. Daten zur Weltentwicklung. Frankfurt/M.: Fischer, S.11 ff.

<sup>3</sup> Weltbank (Hrsg.), (1992). Entwicklung und Umwelt. Washington, D.C., S.1.

der Blüte. 1774 fragte Herder in seinem Werk „Auch eine Philosophie der Geschichte zur Bildung der Menschheit“: „Gibt's einen Faden der Entwicklung menschlicher Kräfte durch alle Jahrhunderte...?“<sup>4</sup>

Das Zeitalter der „Entwicklung“ beginnt mit dem 20.1.1949, als der US-amerikanische Präsident Harry S. Truman in seiner Rede zum Amtsantritt erstmals von „unterentwickelten Gebieten“ der südlichen Hemisphäre sprach. Er begründete das Eingreifen der USA in die Angelegenheiten anderer Länder damit, daß die „Hebung der Industrieproduktion in den zurückgebliebenen Ländern“ der Welt „deren Lebensstandard wesentlich verbessern“ könne. Dahinter stand die Überzeugung, daß eine höhere Produktion den Schlüssel zu Wohlfahrt und zum Frieden bildet.<sup>5</sup>

Der Begriff „Entwicklung“ ist normativ und hat keinen eindeutigen Inhalt. Im umfassendsten Sinne meint „Entwicklung“ eine Verbesserung der Lebensqualität von Menschen und damit einen erwünschten wirtschaftlichen, sozialen, politischen oder ökologischen Fortschritt. Der Begriff ist also weder vorgegeben noch wertneutral. Er ist nicht allgemein definierbar, sondern hängt ab von Raum und Zeit und vor allem von individuellen und kollektiven Wertvorstellungen.<sup>6</sup>

Offensichtlich hat sich in den letzten 40 Jahren kein anderer Begriff weltweit so schnell verbreitet und Eingang in praktisch alle Bereiche von Wissenschaft, Politik und internationaler Zusammenarbeit gefunden wie „Entwicklung“. Erklärungsansätze, Theorien und Strategien, Institutionen und Organisationen, Programme und Projekte haben ihn vereinnahmt. Seit über vierzig Jahren kann man vom Zeitalter der Entwicklungspolitik sprechen.

Kaum ein Begriff wird allerdings auch so vieldeutig, unterschiedlich und mißverständlich benutzt wie „Entwicklung“. Für radikale Kritiker wie Wolfgang Sachs gehört er zu den nichtssagenden „Plastikwörtern“: „Inzwischen ist ‚Entwicklung‘ zu einem qualligen, Amöbengleichen Wort geworden. Es faßt nichts mehr, weil seine Konturen verschwimmen, und es ist unausrottbar, weil es sich überall breitmachen kann. Wer es ausspricht, benennt gar nichts, doch nimmt für sich alle guten Absichten dieser Welt in Anspruch. Zwar hat es keinen Inhalt, aber doch eine Funktion: Es verleiht jedem beliebigen Eingriff die Weihe, im Namen eines höheren, evolutionären Ziels vollzogen zu werden. ‚Entwicklung‘ ist ausgehöhlt bis auf ein leeres Plus.“<sup>7</sup>

Die Rede von Harry S. Truman war gewissermaßen die Eröffnungsansprache zu einer Aufholjagd der als zunächst „unentwickelt“ und später „unterentwickelt“ bezeichneten Länder, die im weiteren Verlauf „Entwicklungsländer“ oder Länder der „Dritten“ oder „Vierten“ „Welt“ oder als „Peripherien“ benannt wurden. Die Industrieländer galten als Vorbild und die sog. Entwicklungsländer im Vergleich dazu als „rückständig“. Der Rückstand sollte überwunden werden. Modernisierung aller Lebens- und Handlungsbereiche nach westlichem Muster war angesagt. Industrialisierung und wirtschaftliches Wachstum sollten den Abstand zu den technisch und wirtschaftlich entwickelten Ländern verringern. Der dort eingeschlagene Weg sollte nachvollzogen werden. Es ging um nachholende Entwicklung, oder anders ausgedrückt: „Wie im Westen, so auf Erden.“<sup>8</sup>

<sup>4</sup> Hier zitiert nach Eppler, E. (1992,18.9.). Die Musterphrase. Die Zeit, S.56.

<sup>5</sup> Inauguralansprache vom 20.1.1949, zit. nach Truman, H.S. (o.J.). Memoiren, Bd. II. Stuttgart: Scherz und Goverts Verlag, S.254 f.

<sup>6</sup> Vgl. Nohlen, D. (Hrsg.) (1993) Lexikon Dritte Welt. „Entwicklung“. Neubearb. Aufl., Reinbek: Rowohlt, S.206.

<sup>7</sup> Sachs, W. (1992). Zur Archäologie der Entwicklungsidee. Frankfurt/M.: epd, S.30.

<sup>8</sup> Vgl. Sachs, W. (Hrsg.), (1993). Wie im Westen so auf Erden. Ein polemisches Handbuch zur Entwicklungspolitik. Reinbek: Rowohlt. Wolfgang Sachs und andere Autoren/innen des Sammelbandes kritisieren radikal Grundannahmen und Grundbegriffe des „Entwicklungszeitalters“, so z.B. Ivan Illich „Bedürfnisse“, Marianne Gronemeyer „Entwicklungshilfe“ und Wolfgang Sachs „Die eine Welt“.

In der ersten Entwicklungsdekade (1961-70) wurde eine Steigerung des Bruttosozialprodukts der Entwicklungsländer um jährlich 5 % eingeplant. Dieses Wachstumsziel wurde im ersten Jahrzehnt erreicht. Der Wachstumsgedanke dominierte auch in den folgenden Entwicklungsdekaden weiterhin alle Vorstellungen von Entwicklungszielen und -wegen. Ulrich Menzel bringt es auf die Formel: „40 Jahre Entwicklungsstrategie = 40 Jahre Wachstumsstrategie“.<sup>9</sup>

Das optimistische Modell der nachholenden Entwicklung mit den Zielen Wachstum, Industrialisierung und Modernisierung galt lange Zeit unangefochten auch in sog. sozialistisch orientierten Ländern der Dritten Welt.

## **Krise der Modernisierungsansätze und der nachholenden Entwicklungsstrategien**

Bereits zu Ende der ersten Entwicklungsdekade zeigten sich Schwächen der rückstandsfixierten Erklärung von Unterentwicklung und Probleme der Wachstumsstrategien. Ursachen der „Unterentwicklung“ lagen nach Überzeugung der Dependenzia-Vertreter weniger in internen Faktoren, sondern in historisch vermittelten und durch die Weltmarktbedingungen aufrechterhaltenen exogenen Einflüssen auf die als strukturell abhängig betrachteten Länder. Das wachsende Massenelend in städtischen Ballungszentren und ländlichen Regionen wurde immer offensichtlicher, so daß A.G. Frank von der „Entwicklung der Unterentwicklung“ sprach. In seiner berühmten Rede 1973 in Nairobi kritisierte der damalige Weltbankpräsident Robert McNamara das Wachstumskonzept. Schnelles Wirtschaftswachstum in Entwicklungsländern war nach seiner Analyse von einer größeren Ungleichheit der Einkommensverteilung begleitet und wirkte sich besonders kritisch in ländlichen Gebieten aus. Nur den reichsten zwei Fünfteln der Bevölkerung war die wachstumsfördernde Entwicklungspolitik zugute gekommen.

Die Hoffnung, daß hohes Wirtschaftswachstum vom Nutzen Weniger zur Masse der Bevölkerung „durchsickern“ wird, hat sich nicht erfüllt. Entsprechende Erkenntnisse und Forderungen finden sich in der „Erklärung von Cocoyok“ (1974). Die Diskussion um diese Erklärung hat dazu beigetragen, daß Entwicklungsziele und -wege neu überdacht wurden. Stich- und Schlagworte in diesem Zusammenhang sind: Grundbedürfnisorientierung, Eigenständige Entwicklung (self-reliance, collective self-reliance), „Umverteilung mit Wachstum“ (redistribution with growth) und „Wachstum von unten“ (growth from below) statt „Entwicklung durch Wachstum“, integrierte ländliche Entwicklung bzw. ländliche Regionalentwicklung statt sektorale Agrarmodernisierung, „Neue internationale Wirtschaftsordnung“, „Menschliche Entwicklung“ (human development/Human Development Index) statt Steigerung des Bruttosozialprodukts.

## **Ökologische Kritik am Konzept der nachholenden Entwicklung**

Anfang der 70er Jahre wurde die Machbarkeit und Wünschbarkeit des nachholenden Weltentwicklungsmodells auch aus ökologischen Überlegungen angezweifelt. 1972 erschien der erste Bericht an den Club of Rome über die „Grenzen des Wachstums“.<sup>10</sup>

Die ressourcenverschwenderische Wachstumspolitik der Industrieländer wurde darin als fragwürdig und nicht nachahmenswert bezeichnet. Die Erkenntnis wuchs, daß das Konsumverhalten und Produktionsniveau in den Industrieländern, auf alle Entwicklungsländer übertragen, vermutlich zu einem weltweiten ökologischen Zusammen-

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<sup>9</sup> Menzel, U. (1992). 40 Jahre Entwicklungsstrategie = 40 Jahre Wachstumsstrategie In: Nohlen, D. und Nuscheler, F. (Hrsg.), Handbuch der Dritten Welt, Bd.1, S. 131-155. Bonn: Dietz Nachf.

<sup>10</sup> Meadows, D. et al. (1992). Die Grenzen des Wachstums. Bericht des Club of Rome zur Lage der Menschheit. Stuttgart.

bruch führen würde. Im zweiten Bericht des Club of Rome wurde 1974 deutlich gemacht, daß Entwicklung nicht Aufholen bedeuten könne. Diese Botschaft war sowohl an die westlichen Modernisierungsvertreter wie auch an die Befürworter des „sozialistischen Entwicklungsweges“ gerichtet. Der Bericht unterstützte die Forderungen der Entwicklungsländer nach einer neuen Weltwirtschaftsordnung. Als Leitprinzipien für eine gemeinsame Entwicklung wurden u.a. genannt: Gleichheit, Freiheit, Demokratie, Partizipation, Solidarität, kulturelle Vielfalt und eine gesunde Umwelt.

Das expansionsorientierte Weltentwicklungsmodell ist somit unter entwicklungspolitischen und ökologischen Gesichtspunkten fraglich. H.-J. Harborth spricht von einem ökologischen Katastrophenmodell. Der von den Industrieländern eingeschlagene Weg der „harten“ Industrialisierung kann schon aus ökologischen Gründen nicht endlos weiterverfolgt werden. Ressourceneinsatz und Umweltzerstörung belasten die Biosphäre. Wenn zudem rund 75-80 % der Weltbevölkerung ein ähnlich hohes Ressourcenverbrauchs- und Umweltbelastungsniveau erreichen würde wie der Rest der Menschen in den Industrieländern, wäre ein ökologischer Untergang der Menschheit unvermeidlich. Das ohnehin konflikträchtige Dilemma wird dabei durch drei Problemverstärker verschärft: a) armutsbedingte Umweltzerstörung in tropischen und subtropischen Ländern;

b) ein armutsbedingtes Bevölkerungsverhalten mit anhaltend hoher Geburtenrate in diesen Regionen und

c) eine Wachstumsideologie, die immerwährendes Wachstum für notwendig und machbar hält.<sup>11</sup>

Bereits 1972 hatte der damalige deutsche Bundesminister für wirtschaftliche Zusammenarbeit auf diese Zusammenhänge eindringlich hingewiesen: „Spätere Generationen werden wahrscheinlich die Köpfe darüber schütteln, wie lange wir zu der simplen Einsicht gebraucht haben, daß auf einem endlichen Erdball mit endlichen Ressourcen die Zahl der Menschen, die Verbrauchsziffern für Rohstoffe, Energie und Wasser nicht beliebig ansteigen können. Sie werden die Köpfe darüber schütteln, wie wir glaubten, ungestraft in Kreisläufe und Gesetzmäßigkeiten der Natur eingreifen zu können. Sie werden manches als windschiefe Ideologie erkennen, was sich heute als realitätsbewußter Pragmatismus gibt.“<sup>12</sup>

Aus global-ökologischen Gründen ist somit der in Industrieländern übliche Pro-Kopf-Standard an Rohstoff- und Energieverbrauch, Produktion, Konsumtion und Umweltbelastung weder jetzt noch in absehbarer Zukunft verallgemeinerungsfähig. Die Industrieländer und die ihnen nacheifernden Statuseliten und Privilegierten der Entwicklungsländer beanspruchen einen oligarchischen Lebensstandard, der eigentlich nur deshalb und solange aufrechterhalten werden kann, wie ihn die große Mehrheit der Weltbevölkerung eben nicht erreicht.<sup>13</sup>

## **Nachhaltige Entwicklung: Solidarität mit Umwelt, Mitwelt und Nachwelt**

Zusammenhänge zwischen Umwelt und Entwicklung werden seit über 20 Jahren international diskutiert, etwa auf der UNESCO-Biosphärenkonferenz (1968), der UN-Konferenz „Der Mensch und seine natürliche Umwelt“ (Stockholm 1972), in der bereits erwähnten Erklärung von Cocoyoc (1974), im Ecodevelopment-Ansatz (I. Sachs 1974/76), im Dag-Hammarskjöld-Bericht (1975/76) und von J. Galtung („Alternative Life Styles in Rich Countries“ 1976).

<sup>11</sup> Harborth, H.-J. (1992), 296.

<sup>12</sup> Eppler, E. (1993). Wie gut sind die Besseren? Der Spiegel, 6, 128-133, hier 130.

<sup>13</sup> Harborth, H.-J. (1992), 238 f.

Der Begriff „sustainable development“ ist 1980 aufgegriffen worden mit der Veröffentlichung „Weltstrategie für die Erhaltung der Natur“. Die Erfordernisse zur Erhaltung natürlicher Grundlagen bei gleichzeitiger auf Dauer angelegter Entwicklung wurde zur gedanklichen Grundlage, auf der die Weltkommission für Umwelt und Entwicklung in ihrem 1987 veröffentlichten Bericht „Unsere gemeinsame Zukunft“ aufbaute. Damit hat dieses Gremium unter dem Vorsitz der damaligen norwegischen Ministerpräsidentin Brundtland den Anstoß zur Weltkonferenz für Umwelt und Entwicklung (UNCED) gegeben, die im Juni 1992 in Rio de Janeiro unter Beteiligung von über 15.000 Vertretern, darunter 115 Staats- und Regierungschefs aus 178 Ländern, stattfand. In den Worten von Volker Hauf, dem deutschen Mitglied der Weltkommission für Umwelt und Entwicklung, die den sog. „Brundtland-Bericht“ verfaßte, bedeutet sustainable development „dauerhafte“ bzw. „nachhaltige“ Entwicklung: „Unter dauerhafter Entwicklung verstehen wir eine Entwicklung, die den Bedürfnissen der heutigen Generation entspricht, ohne die Möglichkeiten künftiger Generationen zu gefährden, ihre Bedürfnisse zu befriedigen und ihren Lebensstil zu wählen. Die Forderung, diese Entwicklung 'dauerhaft' zu gestalten, gilt für alle Länder und Menschen. Die Möglichkeit kommender Generationen, ihre eigenen Bedürfnisse zu befriedigen, ist durch Umweltzerstörung ebenso gefährdet wie durch Umweltvernichtung und durch Unterentwicklung in der Dritten Welt.“<sup>14</sup>

Dauerhafte oder nachhaltige Entwicklung ist somit keineswegs ein ausschließlich technischer Begriff, sondern beinhaltet ein ganzes Bündel von gesellschaftlichen Werturteilen und Beurteilungskriterien, was besonders durch das folgende Zitat aus dem Brundtland-Bericht deutlich wird: „Mögen die Bilanzen unserer Generation auch noch Gewinne aufweisen - unseren Kindern werden wir die Verluste hinterlassen. Ohne Absicht und Aussicht auf Rückzahlung borgen wir heute von zukünftigen Generationen unser 'Umweltpapier'. Unsere Nachfahren mögen uns ob unseres verschwenderischen Vorgehens verfluchen - unsere Schulden werden sie nicht mehr eintreiben können. Unser Verhalten ist bestimmt von dem Bewußtsein, daß uns keiner zur Rechenschaft ziehen kann. Künftige Generationen haben heute kein Wahlrecht, sie verfügen über keinerlei politische oder finanzielle Mittel und sind uns daher ohnmächtig ausgeliefert.“<sup>15</sup> Diese Gedanken belegen: Eine Strategie der Nachhaltigkeit muß sich zur Solidarität mit allen gegenwärtig und in Zukunft lebenden Menschen (Mitwelt, Nachwelt) und der Umwelt bekennen. Unter Einbeziehung dieser Grundgedanken und Aspekte kann hier festgehalten werden: Nachhaltige Entwicklung erfordert die Solidarität mit der Umwelt, Mitwelt und Nachwelt.<sup>16</sup> Diese Sicht der Nachhaltigkeit lehnt sich an G. Altners Vorstellung an, daß eine ökologisch orientierte Wissenschaft Solidarität fördert und fordert und nicht die Beherrschung von Natur und Gesellschaft zur Grundmotivation hat.<sup>17</sup> Dieses Verständnis von Nachhaltigkeit findet sich auch z.B. in der „dynamischen“ Definition von „Sustainable Agriculture“ der Consultative Group on International Agricultural Research, nach der eine nachhaltige Nahrungsmittelproduktion voraussetzt, daß diese in der Lage ist, einen steigenden Bedarf zu decken und gleichzeitig die Qualität der Umwelt und die natürlichen Ressourcen dauerhaft zu erhalten.<sup>18</sup>

<sup>14</sup> Hauf, V. (1987), (Hrsg.). Brundtland-Bericht: Weltkommission für Umwelt und Entwicklung: Unsere gemeinsame Zukunft. Greven, XV.

<sup>15</sup> Brundtland-Bericht, 9.

<sup>16</sup> Vgl. dazu Mai, D.(1993). Nachhaltigkeit und Ressourcennutzung. In: R. Stockmann und W. Gaebe (Hrsg.), Hilft die Entwicklungshilfe langfristig? Bestandsaufnahme zur Nachhaltigkeit von Entwicklungsprojekten.(S. 96-121). Opladen: Westdeutscher Verlag.

<sup>17</sup> G. Alter et al. (1985) Manifest zur Versöhnung mit der Natur. 3. Aufl. Neukirchen-Vluyn.

<sup>18</sup> Consultative Group on International Agricultural Research - Technical Advisory Committee (1982). Sustainable Agricultural Production: Implications for International Agricultural Research. Rome, S.2.

## Umwelt-, mitwelt- und nachweltgerechte Entwicklung zwischen Einsicht und Umsetzung

Die Erkenntnis, erneuerbare und nichterneuerbare Ressourcen nachhaltig, also um-, mit- und nachweltgerecht zu nutzen, ist inzwischen in Wissenschaft, Politik und Wirtschaft verbreitet und keinesfalls neu. So hat beispielsweise das Prinzip der Nachhaltigkeit in der deutschen Forstwirtschaft eine über 200-jährige Tradition.<sup>19</sup>

„Neue Grenzen des Wachstums“ zeigen sich jedoch immer deutlicher in der Knappheit von aufnahmefähigen Umweltmedien für Abfälle und Schadstoffemissionen. Die Erschöpfung der Tragfähigkeit der globalen Gemeingüter äußert sich z.B. im sog. Treibhauseffekt, der Zerstörung der Ozonschicht und der grenzüberschreitenden Luft- und Wasserverschmutzung. Es geht dabei um überregionale und z.T. kontinentüberschreitende Externalisierung von „Kosten“ des Ressourceneinsatzes und Energieumsatzes.<sup>20</sup>

In dem „Erdgipfel“ in Rio gelangte die Umwelt- und Entwicklungsdiskussion zu einem Höhepunkt der internationalen Bemühungen, geeignete Wege einer nachhaltigen Entwicklung in Nord und Süd festzulegen und der wachsenden Zerstörung des Globus und der zunehmenden sozialen Verelendung der Menschen Einhalt zu gebieten (UN-Resolution 44/228).<sup>21</sup> Nach Auffassung der deutschen Bundesregierung war die Umwelt- und Entwicklungskonferenz in Rio ein Erfolg: Die Konventionen zu Klima und biologischer Vielfalt, die Walderklärung, das Aktionsprogramm „Agenda 21“ und der Beschluß zur Einrichtung der UN-Kommission für nachhaltige Entwicklung bilden aus der Sicht der Bundesregierung die Grundlagen für eine qualitativ neue weltweite Zusammenarbeit in der Umwelt- und Entwicklungspolitik. Damit sind auch Wege von der Erkenntnis in die praktische Umsetzung aufgezeigt. Die Deklaration beinhaltet das Recht auf Entwicklung, anerkennt die Notwendigkeit der Armutsbekämpfung und angemessener Bevölkerungspolitik und betont die besondere Verantwortung der Industrieländer als wesentliche Verursacher für bisher entstandene globale Umweltschäden. Die Deklaration hebt u.a. auf das Vorsorge- und Verursacherprinzip ab, fordert die Integration des Umweltschutzes in alle Politikbereiche sowie die Durchführung von Umweltverträglichkeitsprüfungen und die Beteiligung der Öffentlichkeit bzw. gerichtliche Kontrollmöglichkeiten. Sie verlangt ebenfalls eine wirksame Umweltgesetzgebung und betont die Bedeutung des Einsatzes ökonomischer Instrumente und der Internalisierung externer Kosten. Damit dürfte nicht nur ein wichtiger weltweiter Bewußtseinswandel erreicht, sondern eine für ihren Bereich vergleichbare Wirkung entfaltet werden wie die KSZE-Schlußakte von Helsinki.<sup>22</sup> In dem Aktionsprogramm „Agenda 21“ werden auf rund 800 Seiten für 40 Bereiche der Umwelt- und Handlungspolitik detaillierte Ziele vorgegeben und Maßnahmen und Instrumente zur Zielerreichung benannt. Die Handlungsaufträge wenden sich an alle Industrie- und Entwicklungsländer.

Die Rio-Konferenz kann je nach Standpunkt oder Bewertungskriterium als weitgehender Mißerfolg, ungewisser Teilerfolg oder als Wendepunkt gewertet werden.<sup>23</sup> Positiv

<sup>19</sup> Vgl. hierzu Mai, D. (1993).

<sup>20</sup> Gleichzeitig wächst die arbeitsbedingte Ressourcenzerstörung in Entwicklungsländern, insbes. z.B. durch Ausdehnung der landwirtschaftlichen Produktion in marginale, ökologisch fragile Regionen (Bodenerschöpfung und -verarmung, Erosion, Entwaldung usw.)

<sup>21</sup> Hier zitiert nach „Sustainable development“ (1993). Nohlen, D.(Hrsg.). Lexikon Dritte Welt, S. 642-647, hier S. 642 f.

<sup>22</sup> Vgl. Bundesminister für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ) (1992). Umwelt und Entwicklung. Bericht der Bundesregierung über die Konferenz der Vereinten Nationen für Umwelt und Entwicklung im Juni 1992 in Rio de Janeiro. Entwicklungspolitik: Materialien Nr. 84. Bonn, S.3.

<sup>23</sup> Einzelne Positionen können im Rahmen dieses Beitrags nicht diskutiert werden. Vgl. hierzu z.B. H. 51/52 (1993) Peripherie: Neue Umweltordnung? Theorien und Strategien nach Rio; sowie von Weizsäcker, E.-U.

ist zu vermerken, daß bestimmte Gegebenheiten und Verhaltensweisen in Rio offen diskutiert wurden, beispielsweise das Konsumverhalten (Kapitel 4 der Agenda 21). Dabei wird deutlich ausgesprochen, daß Armut und Umweltschädigung eng miteinander verknüpft sind. „Hauptursache der globalen Umweltprobleme sind aber die nicht nachhaltigen Verbrauchs- und Produktionsmuster besonders in den industrialisierten Ländern. Während in einigen Teilen der Welt übermäßig konsumiert wird, werden die Grundbedürfnisse eines großen Teils der Menschheit nicht befriedigt... Alle Länder sollen deshalb nachhaltige Konsummuster und Lebensweisen anstreben; die Industrieländer müssen dabei vorangehen. Ein Wertewandel ist hierfür die notwendige Voraussetzung“.<sup>24</sup>

Für die Anwendung dieser Einsichten in den Industrieländern werden entsprechende Vorschläge gemacht, die aus der Ökologiediskussion weitgehend bekannt sind.<sup>25</sup>

Voraussetzung für „Umdenken“ und „Umlenken“ ist somit zunächst ein Denken in um-, mit- und nachweltgerechten Zusammenhängen. Die dabei gewonnenen Erkenntnisse und die Benennung von Verantwortlichen sind unerlässlich für die Vorgabe von Zielen, Maßnahmen und Instrumenten.

Erst in neuerer Zeit befaßt sich die Wirtschaftswissenschaft systematischer mit der Einbeziehung und Quantifizierung des Verbrauchs nicht-erneuerbarer Ressourcen sowie mit dem Verlust von landwirtschaftlich genutztem Land durch Bodenabtrag und den Kosten der Luft- und Wasserverschmutzung bei der Berechnung des Bruttosozialprodukts. Statt des Pro-Kopf-Bruttosozialprodukts wird z.B. ein Index Dauerhafter Ökonomischer Wohlfahrt vorgeschlagen, der die externalisierten Kosten berücksichtigt. International bekannt geworden sind die Vorschläge des „Weltbank-Ökonomen“ H.E. Daly zur Umgestaltung der Wirtschaft in Richtung Nachhaltigkeit. D.H. Meadows et al. weisen in Modellrechnungen nach, daß nachhaltige Entwicklung technisch und wirtschaftlich realisierbar ist. Voraussetzung dazu ist eine vorsichtige Balance zwischen lang- und kurzfristigen Zielen und die Hinwendung zu Genügsamkeit, Gleichheit und Lebensqualität anstatt materiell-physischem Wachstums.

Wie aber die allseits akzeptierten Einsichten dann in praktischen Schritten in einzelnen Regionen und Staaten verwirklicht werden sollen, ist umstritten und weitgehend ungelöst. Das zeigt sich besonders deutlich an der Forderung nach einem geänderten Lebensstil in Industrieländern und entsprechenden Maßnahmen zu ihrer Einlösung. In einigen Bereichen sind jedoch erfolgversprechende Ansätze vorhanden. So liegen beispielsweise für die Niederlande Untersuchungen vor, die nachweisen, daß „sustainable Netherlands“ ein qualitatives Wirtschaftswachstum mit erheblich geringerem Ressourcenverbrauch, Energiedurchsatz und Umweltbelastungen bei geänderterem Lebensstil erreichen kann. Es gibt darüberhinaus ermutigende Ansätze in Politik, internationaler Entwicklungszusammenarbeit und privater Wirtschaft, Einsichten und Umsetzungsvorschläge zur Förderung nachhaltiger Entwicklung zu verbreiten. Beispiele dafür sind Bücher des US-amerikanischen Vizepräsidenten Al Gore „Wege zum Gleichgewicht. Ein Marshallplan für die Erde.“ (1992) und des Schweizer Industriellen Stephan Schmidheiny „Kurswechsel. Globale unternehmerische Perspektiven für Entwicklung und Umwelt“ (1992).

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(1992). Erdpolitik. Ökologische Realpolitik an der Schwelle zum Jahrhundert der Umwelt. 3. akt. Aufl. Darmstadt: Wiss. Buchges.

<sup>24</sup> BMZ (1992), S. 17.

<sup>25</sup> Vgl. dazu etwa Brown, L. et al. (1991). Zur Rettung des Planeten Erde. Strategien für eine ökologisch nachhaltige Weltwirtschaft. Frankfurt/M.: S. Fischer und Immler, H.(1990). Vom Wert der Natur. Zur ökologischen Reform von Wirtschaft und Gesellschaft. 2. Aufl. Opladen: Westd. Verl.

Die Weltbank hat den Weltentwicklungsbericht 1992 dem Thema „Entwicklung und Umwelt“ gewidmet und inzwischen sog. Umwelt-Aktionspläne („Environmental Action Plans“) zur schrittweisen Umsetzung der Agenda 21 vorgelegt. Ein Umwelt-Aktionsplan ist als Instrument zu verstehen, um jeweils in einem Land nachhaltige Entwicklung mit internationaler Unterstützung auf den Weg zu bringen.<sup>26</sup> Die Umsetzung eines auf Nachhaltigkeit und Umweltverträglichkeit angelegten Entwicklungsansatzes ist sektor- und grenzübergreifend und somit komplex. Daher ist ein pragmatischer Aktionsrahmen erforderlich, der notwendige Schritte und Maßnahmen kurzfristig ermöglicht und strategische Entscheidungen langfristig vorbereitet und einleitet. Sicherlich wird es dabei eher auf die richtige Prozeßabfolge von Richtungsbestimmungen und Teilschritten und weniger auf umfassende und in sich stimmige „Alles-oder-Nichts-Konzepte“ ankommen.<sup>27</sup>

Die FAO hat das Anliegen von Rio durch ein „Special Action Program“ in 12 Bereichen in die laufende Arbeit integriert. Unter der Bezeichnung SANE (Sustainable Agriculture Networking and Extension) begann die UNDP mit einem Programm, das von Nicht-Regierungsorganisationen auf Mikroebene in einigen Ländern durchgeführt wird. Private Organisationen in Europa unterstützen im Bereich Landwirtschaft seit langem Ideen, wie z.B. den „standortgerechten Landbau“. Ihnen bereitet die Umbenennung ihrer Ansätze in die „neue“ Terminologie „nachhaltige Landwirtschaft“ keine Probleme. Kontinental und international arbeitende Netzwerke wie AGRECOL, IFOAM, ILEIA, CLADES und INADES sehen sich seit vielen Jahren den Ideen und Ansätzen verpflichtet, die nun in der Rio-Nachfolge als nachhaltige Landwirtschaft politisch eher akzeptiert und umgesetzt werden können.<sup>28</sup>

Das Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung versucht, Beschlüsse der Rio-Konferenz in die praktische Entwicklungszusammenarbeit einzubringen. In dem Rechenschaftsbericht („UNCED follow up“-Bericht) „Rio - ein Jahr danach. Was tut das BMZ?“ werden konkrete Schritte und Aktionen (u.a. Umweltverträglichkeitsprüfungen in der Entwicklungszusammenarbeit) aufgeführt, aber auch auf die finanziell eng begrenzten Spielräume zur Realisierung notwendiger Maßnahmen hingewiesen.<sup>29</sup> Die internationale Konkurrenzsituation zwischen Ländern und Ländergruppen und der damit einhergehende Wettbewerb um kostengünstige Standorte und Produkte dürfte ebenfalls dazu beitragen, nachhaltige Entwicklungskonzepte an einer schnellen Verbreitung zu hindern. Tatsache ist zudem, daß einige sog. Schwellenländer („Newly Industrialized Countries“) in Asien und Südamerika die Industrialisierung weiterhin stark forcieren und Gedanken der nachhaltigen Entwicklung reserviert gegenüberstehen.

## Fazit und Zukunftsorientierung

Wer sich wissenschaftlich mit nachhaltiger Entwicklung befaßt oder politisch für sie eintritt, teilt durchweg die Auffassung, daß es so wie bisher nicht weitergehen kann und daß nur noch wenig Zeit für eine Kurskorrektur verbleibt. Der von den Industrieländern vorgelebte Weg der „harten“ wachstumsorientierten Entwicklung kann schon aus ökologischen Gründen (Ressourcenerschöpfung, Umweltbelastung) nicht endlos weiterverfolgt werden. Zweifellos wollen jedoch viele Menschen in armen Weltregionen auch in Zukunft diesem Entwicklungspfad folgen. „Vorbilder“ über Fernsehen und

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<sup>26</sup> Otzen, U. (1993). Umwelt-Aktionspläne. Ein Handlungsrahmen zur Umsetzung von nachhaltiger Entwicklung? Berlin: DIE.S.I.

<sup>27</sup> Otzen, U. (1993), S.1)

<sup>28</sup> Vgl. dazu H.1/1994 von epd-Entwicklungspolitik „Nachhaltige Landwirtschaft“.

<sup>29</sup> BMZ (Hrsg.)(1993) Bonn.

andere Medien erreichen inzwischen auch die letzten Winkel dieser Erde. Gleichfalls besteht weitgehende Einigkeit darüber, daß für alle gegenwärtigen und zukünftigen Menschen Grundbedürfnisse erfüllbar bleiben müssen. Ausgehend von diesen Überlegungen dürften die folgenden Schlußfolgerungen eine entsprechend große Zustimmung erfahren.<sup>30</sup>

Für die arme Mehrheit der Menschheit erscheint materielles Wachstum unverzichtbar. Anzustreben ist dabei jedoch „qualitatives“, sozialverträgliches und umweltgerechtes dauerhaftes Wachstum („Ecodevelopment“) sowie die Erreichung eines materiellen Mindestniveaus (Dag-Hammarskjöld-Bericht). „Nachholende“ Entwicklung im diesem Sinne ist dann vertretbar.

Nachholende Entwicklung mit steigendem Ressourcenverbrauch und wachsender Schadstoffemission auf globaler Ebene führt in einen „ökologischen“ Abgrund.

Es geht letztlich um ein neues entwicklungspolitisches Verständnis, das auf Nachhaltigkeit abstellt. Die Menschen in den verschiedenen Entwicklungsregionen ändern ihren Lebensstil und ihr Verbraucherverhalten. Sie versuchen gemeinsam ein ökologisches Gleichgewicht zu erhalten, damit allen heutigen und zukünftigen Menschen ein ausreichender materieller, sozial verträglicher und dauerhafter Lebensstandard ermöglicht wird.

Rio hat in dieser Richtung Zeichen gesetzt, Ziele, Maßnahmen und Instrumente benannt. Unzweifelhaft liegt es nun an den Industrieländern, in glaubwürdiger Weise und mit der in anderen Zusammenhängen so oft bewiesenen Effektivität und Effizienz mit Umstrukturierungen und praktischen Maßnahmen zu beginnen. Somit tragen die Industrieländer für die Umsetzung von Erkenntnissen zur ressourcenschonenden und dauerhaften globalen Entwicklung die Hauptverantwortung. Dabei ist es letztlich unerheblich, ob sie diese Rolle aus Gründen der Solidarität im Sinne von Verantwortung für die Umwelt, Mitwelt oder Nachwelt übernehmen oder lediglich aus der Einsicht in die Erfordernisse des Überlebens der Menschheit.

„Was heißt also Entwicklung? Wer muß entwickelt werden? Etwa nur die anderen? Nicht auch wir selbst? Das heißt aber: Alle großen sozialen, ökonomischen und ökologischen Fragen müssen zugleich auch durch Veränderung bei uns selbst angegangen werden. Wir müssen anders leben, damit andere leben können.“<sup>31</sup>

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<sup>30</sup> Vgl. dazu Harborth, H.-J. (1991). Dauerhafte Entwicklung statt globaler Selbstzerstörung. Berlin: Ed. Sigma. S. 95 ff.

<sup>31</sup> Bischof Franz Kamphaus (1991) hier zit. nach epd Dritte Welt Information. Arbeitsblätter 11/12. Was ist Entwicklung? S. 3.

## Desertification and migration - a challenge to co-operation

### Food for thought for Egypt

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### Introduction

Since the 1980s, desertification<sup>1</sup> of arid regions<sup>2</sup> is an issue which increasingly raises concern of the international community. After a period during which the ecological aspects of the phenomenon have been in the focus of interest, since the 1990s, the interrelationship between desertification and population growth has aroused increasing attention and has alarmed politicians and scientists alike. High rates of population growth in arid regions whose limits of ecological carrying capacity are obvious, suggest that out-migration of part of the population would be a positive solution. Hence, observed adaptive processes by out-migration are regarded as more a problem of the receiving regions, like urban centres, than of the sending areas. The question what results for arid source regions raises less concern, as out-migration from there is considered as a relief.

In the whole Middle East and North Africa (MENA) region which is one of the most fragile environments of the world, at the same time arid, affected by desertification and characterised by high natural population growth, migratory movements play a decisive and increasingly important role for the economic development. As regional discrepancies between economic carrying capacity and population density grow, people look for alternatives outside. Few studies, however, have been searching for the consequences which these adaptive processes bear on the region of out-migration and on the population which is left behind.

This also applies to Egypt, which is a striking example to the conditions which prevail in the region. The role of migratory movements that take place in reaction to increasing desertification, can hardly be overestimated. Nevertheless, when going through the available literature it becomes obvious that almost no research has been done about this issue. Hence, a paper issued by the World Bank with the initial intention to provide an overview over Egypt's demographic development, its causes and consequences, starts with the diagnosis: „Data on migration are so unreliable and the prospects for migration to relieve population pressure are so uncertain that this paper concentrates on changes in mortality and fertility„ (Cochrane and Massiah 1999:1). Few studies have been done about the impact of international labour migration on the rural home regions of the migrants, in spite of the fact that international labour migration is a dominant factor of the country's economic development. Even more scarce are studies which focus on the impact of internal migration on the rural source regions.

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<sup>1</sup> According to what has been agreed at the 1992 Earth Summit, desertification is defined as „land degradation in arid, semi-arid and sub-humid areas resulting from various factors, including climatic variations and human activities.“ (Secretariat of the UNCCD 1995:12)

<sup>2</sup> Arid regions are defined as those with an average precipitation of less than 200 mm p.a. Semi-arid regions are those with a precipitation of 200 to 400 mm p.a. (WRI 1994)

Against that background, it is essential for policy makers in all areas, to gain more insight into the causes and consequences of these migratory movements and about their interrelationship with the process of desertification. Without specific knowledge about these issues, serious development policies in such regions are not possible. This is demonstrated by the case studies presented below. They show that out-migration provoked by increasing discrepancies between population density and economic carrying capacity may lead to implications in the source regions which would not have been anticipated by reflections based on theoretical considerations or general experiences (see also Knerr 1998 and 2000).

The problems arising from large scale migratory movements have their roots in the arid regions but - on a political, social and economic level - may bear consequences for the global human community through across-border migrations, water shortages, food deficits and social unrest. Therefore, they constitute a challenge to international co-operation to influence this process where necessary which is in the self-interest of other nations, too.

As increasing desertification is, in many arid regions all over the world, both a result of and a threat to human activities, scientific co-operation is necessary on a global scale to collect, compare and draw conclusions from experiences made. This is a central issue of the future of mankind, implying questions of food security, of social peace and of international conflicts.

In order to stimulate the discussion in this area, the author presents theories and experiences made in arid regions affected by desertification. By this, it is intended to provide a background for building up scenarios which might be used as a basis for formulating research hypotheses for individual cases.

Two phenomena are considered which in practice are difficult to disentangle with regard to which came first, but which both lead to the same result: firstly, desertification which entails an increasing discrepancy between population density and carrying capacity and hence out-migration; secondly population pressure which leads to desertification and as a consequence to out-migration. Pressure can come from both sides, from the natural environment which degrades or from the growing population which causes the degradation. Without asking for initial causalities, the paper analyses the interactions which characterise the following-up process are analysed. In this context, problems which face the MENA region are exemplified by Egypt.

## **Background**

Land degradation and desertification in drylands is one of the major challenges to food security world wide. The MENA region, including Egypt, is particularly concerned with this. Over the last decades, desertification has accelerated. Most of this is man-made, as population and increasing claims entail land degradation „...with rising income expectations and standards of living, higher agricultural yield levels are necessary. And this is why in the course of development land which has been regarded until now as fertile will become marginal land, and the previously marginal land will go out of production,, (Andrea 1977; cit. from Wolff 1993). Under these conditions, the carrying capacity of arid region declines due to both decreasing productivity and growing aspirations, and it is attractive for people to move away.

It cannot be concluded a priori that population movements which take place in reaction to increasing population pressure on a given resources' basis and/or in reaction to an erosion of the resource basis, tend to support the way to a stable equilibrium between both. They might as well contribute to a permanently unstable situation, implying a threat to the natural environment and to the people living in it. The out-come of the interactions depends on the social, political and economic framework which is set on the international, national and local level. The following case studies will provide insights into prevailing relationships.

Egypt is among the most arid countries in the world with almost 100% share of arid land in total land (WRI 1999), characterised by increasing desertification. With a population growth of almost 3% p.a. (World Bank 1999) and a share of around 47% of its labour force working in agriculture (el-Hawari 1998:70), taking care of agricultural sustainability is of vital importance for the country.

Agriculture supplies a share of 16.7% to the country's GDP which is a decline from 27.1% in 1977 (World Bank 1999). In 1998 the growth rate of agricultural production has been 2.6% , and hence lower than the growth rate of the population (World Bank 1999). The total cropland per capita of the population is only 0.05 ha, and over the last decade this figure has declined by 11.5% (WRI 2000). The World Resources Institute comments on that: „agricultural land being lost to urbanisation and windblown sands; increasing soil salinisation below Aswan High Dam; desertification; ...; other water pollution from agricultural pesticides; ...; very limited natural fresh water resources away from the Nile which is the only perennial water source; rapid growth in population overstraining natural resources.“ (WRI 2000). This situation is no exemption in the whole MENA which altogether experienced a decline of 13.7% of its total cropland over the last decade (WIR 2000). Although food production in the country has been increasing by a remarkable 72% over the last decade (WRI 2000), for many years, the growth of agricultural production, in particular food production, has lagged behind the country's population growth (Wolff 1993:103). Over the last two decades, the growth rate of agricultural production has displayed a slow but steady decline. There is not much scope for increasing the agricultural productivity much further. The possibilities for irrigation seem to meet their limits; according to the information of the World Resources Institute, 116% of the total cropland is already irrigated (WRI 2000). This gap between population growth and growth of food production can also not be closed by land reclamation in which many governments have put tremendous efforts for centuries (see Wolff 1993).

The move from the rural regions to the urban centres, in particular to Cairo and Alexandria, goes on, although the government has made attempts to stop it, by resettlement schemes and other programmes. Hence urbanisation has been steadily increasing and has reached more than 45% of the population. The question what this implies for the rural regions, from where the migrants come has not been answered sufficiently. Well known and influential theories on migration stress the advantages of such migratory movements out of strained regions as they seem to take population pressure away from them and imply a better relationship between carrying capacity and population density. However, as will be demonstrated below, out migration might not be a favourable solution for rural development.

Under these conditions, Egypt is at a critical stage, where the gap between population growth and growth of food production becomes increasingly wider, desertification pro-

ceeds, and population movements out of rural regions accelerate, with unknown outcome for the rural regions carrying capacity.

In spite of the fact that it is a century old phenomenon in Egypt which has significantly gained momentum over the last decades, and in spite of its close relationship with core political issues of the country (Toth 1999), in particular internal migration in its consequences has been insufficiently investigated. In her book about the consequences of migration on Egypt's labour market, el-Hawari states that although a widespread phenomenon with far-reaching economic and political consequences, internal migration in Egypt is not reflected in the actual literature (el-Hawari 1998:127). She, therefore, concentrates more on theoretical reflections and on international migration.

More attention is paid to international migration. It is important for Egypt's economic development, and due to its contribution to the country's inflow of foreign exchange and its relief for the labour market, has received much attention on the political level. At the same time, it has been investigated far more from the scientific side than internal migration. One reason might for this might also be that data about international migration are more easily available as they imply cross-border transactions (out-migration, in-migration, bank transfers) which are registered more than internal transactions. Hence, a number of sophisticated studies about the impact of international migration exists, often concentrating on the macro-level impact of remittances (see, e.g. Farrag 1995). Investigations about the economic and demographic determinants and social implications of international migration allow some rough and indirect conclusions about the impact on the source regions (see, e.g. Adams 1993; Nasrat 1999). This contrasts sharply with the lack of knowledge about internal migration, its dimensions and consequences.

According to the traditional neo-classical theory of migration, people tend to move to where they expect to receive the highest income, taking care of aspects like transaction costs, risk and uncertainty and employment chances (Knerr 2000). As in rural regions of low-income countries income is largely determined by natural resources, spreading desertification c.p. implies an increasing gap between the income in the region of origin and the income which might be expected in other regions, and, as a consequence a rise in out-migration which takes pressure away from the source region. This in turn, implies declining population pressure in the source region, leading to a more balanced regional distribution of the population and an approximation of real incomes in both regions. Famous and influential models of migration and rural-urban development, like those of Lewis (Lewis 1954), Fei / Ranis (Ranis and Fei 1961) and Todaro (Todaro 1976) put this aspect into the centre of their analysis. In fact, large-scale migratory movements out of regions hit by desertification are observed all over the world (UNCCD 1998) lending support to the results of such theories.

Yet, reality shows that the times for peaceful settlement migration of larger numbers of people who wanted to leave their home region are over. This applies, first of all to across-border migration, but increasingly also to internal migration. As a result over the last decades of the 20th Century, migratory movements have increasingly become temporary and selective (Knerr 1998b). Hence, questions about the impact of out-migration on the source regions have to extend not only to the consequences of out-migration, but must also include those of return migration and the inflow of financial and other resources brought or send by the migrants.

A major consequence of temporary migration patterns is the permanent interaction between the migrant and his family/household in the source region. This interaction extends to many levels of the migratory process, from the decision who will migrate and when, over the extent and use of remittances up to decisions of return. Moreover, interactions with the home community build up migration chains which promote and shape following-up migration processes.

The following case studies demonstrate a set of different consequences of out-migration which result under various socio-economic and cultural conditions.

### **Circular labour migration within the framework of traditional family / household strategies**

Strategies to cope with adverse environmental conditions have existed in arid regions since ancient times. In many regions, they have been essential for the survival population. In many locations, they continue according to established patterns, although in the present time, due to rapidly changing external conditions, i.e. desertification and population growth, they have assumed other dimensions. Adaptations take place within this given framework, often build on long-term stable adaptations to stable arid environments, such as pastoralism or patterns of regular seasonal and circular labour migration (see, e.g. Scoones 1995, Prothero 1998 ).

An example of this kind of migration are the people of Senegal. Their migratory patterns are pre-determined by historically established survival strategies which display typical differences between ethnics. This is demonstrated by Dia's detailed study of the migration strategies of the Kaskas, the Soninké, the Seres and the Haal Pular (Dia 1992). Common to them is that migration decisions are taken jointly by the social unit the migrant belongs to, and that migration/remittance strategies are pursued with the intention of supporting the existence of the reproductive unit at the place of origin.

The Kaskas live under climatic conditions which make labour demand on the farms peak over a short period. In addition, due to insecure rainfall, irrigation is essential for increasing and securing agricultural productivity. On the irrigated lands, external labour is particularly important due to the extremely narrow calendar of cultivation.

The Kaskas on the average have 1.5 out-migrants per household. Their agricultural development strategies include special forms of temporary migration which embrace mainly the younger age groups. Migration income is the most important component of non-agricultural income among the Kaskas. In 1988, each household on the average received 65.800 F CFA p.a. which is equivalent to a salary for 188 to 268 working days.

Behind this average migration situation there are important differences between household groups which have a decisive impact on the economic situation of the whole region. Three typical groups can be identified: a) households where about 75% of the men are migrants. They are able to subsidise their farms by migrants' remittances which pay for inputs and external labour. b) large production units with few migrants; in spite of large areas of land per household (74 ha on average) only an average of 2.6 ha is cultivated due to lack of external income to hire labour, buy inputs and finance irrigation parameters. Here, land productivity is low, farm households are

indebted and suffer from food deficits. c) small production units without migrants; they are the worse off. In spite of their small area of land, they are not able to satisfy their need for labour. Although they employ innovative technologies, like direct seeding etc., they are not able to compensate for the lack of labour and inputs. As a consequence of this, families with migrants accumulate large land holdings. The head of the production unit secures the farm management. The production units which have the most migrants are enlarging their irrigated area at the most, and their mechanise more than others. Yet, these farm activities are not sustainable out of their own resources. The net return of their investment is negative, and it would not be possible to finance them out of the farm income. Hence, the applied migration-remittance strategies allow the families to continue their life in their arid home region, which otherwise might not be possible.

Similar strategies are common in other ethnic groups of the population of Senegal (Dia 1992). Of the Haal Pular more than 90% of the men between 30 and 60 years of age have migrated at least once in their life. 58% of the migrants move to towns within Senegal, 35% to those in Mauritania, and 6% even further away. Households in the home villages on average consist of 1.4 men present, 2.2 women present and two absent men or women, not including the seasonal migrants. Close ties maintained within the clan support highly organised seasonal migration patterns. So, households established in Dakar take over the responsibility for young migrants arriving there.

High rates of migration are also observed among the Seres, with 48%, and the Soninké. The movements of the Seres whose tradition of migration to Dakar only dates back to the 1980s have intensified significantly with the increasing droughts in the region. As a result, the Seres are distributed over Dakar, the Terres Neuves and their home region in Central Senegal, and between these regions there are intense movements, supported by strong social networks. Decisions about migration are usually taken within the family subgroup consisting of the mother and her children, in coordination with the head of the farm-household unit.

The Soninké are specialised in long-distance migration. In the 1960s they had taken part in the labour force agreement between Senegal and France. In 1975, when the French government decided to stop in-migration from Africa, 83% of the out-migrated Soninké were in France. Afterwards, some illegal movement to France carried on, and in addition new international paths established themselves, in particular to Central and Western Africa. At the Soninké, the oldest who heads the social group living, cultivating and consuming together, decides on migratory movements, organises the out-migration and decides on the use of remittances. On the average such a group consists of 16 persons.

Similar strategies of maintaining the reproductive unit in the rural area by subsidising agricultural activities by migrants' remittances are common in other arid regions of Africa, as, for example, in the Communal Areas of Zimbabwe where the subsistence needs of the smallholder families can only be met due to migrants' remittances which are used to buy the necessary inputs (Hedden-Dunkhorst 1993). In addition, this is accompanied by long-term migration-cum-remittance strategies, which aim at giving the children a good school education which later on will put them into a position to earn a higher income allowing for higher remittances.

All of the described strategies can only be successful, as long as the migrants are able to find employment which provides them with a surplus to transfer to their home region. With increasing desertification, accompanied by mounting population pressure these strategies are increasingly threatened to fail. Mauritania provides an example where they definitely have collapsed (Fahem 1998). While the country's nomadic areas are emptying, urbanisation increased from 8% to 47% between 1965 and 1988. This development has been promoted by the availability of water and food supplied by international aid organisations to urban centres. Hence, many were attracted by these supplies and not by well-paid jobs. Although out-migration from rural areas is highly selective in favour of the younger males, which deprives the rural regions of their most productive labour force, hardly any resources flow back there. The gender distribution in the rural areas is significantly in favour of women, while in the urban areas it is the reverse. One third of all households in the country are headed by women. In the face of increasing desertification on the one hand and continuing high population growth on the other hand, the largest part of Mauritania's population today is threatened by hunger and thirst. For a large part of them, only international aid secures the survival.

In addition, as has been demonstrated through a study by Knerr and Schrieder (Knerr and Schrieder 2000; Schrieder and Knerr 2000), migration-cum-remittance strategies seem to support first of all those in the home region who possess productive resources. It shows that in rural regions of Cameroon, not all of those who have migrant family members are supported in case of need. The amount of remittances received is not negatively correlated with the income of the migrant's family member at home, - as would be expected under the assumption of altruism -, but positively with the number of animals and the amount of land the remittee holds, and the remitter might inherit. The example of Cameroon demonstrates that migration strategies might be more a way to preserve productive capital in a strained region, than just a strategy to maintain the living standard of those left behind. A study made by Lucas in the mid-1980s in Botswana seems to point into a similar direction (Lucas 1985; Lucas and Stark 1985).

## **Out-migration for resettlement**

Migration out of arid regions for resettlement as a rule means movement to urban centres and increasing urbanisation. In fact, in all arid countries, cities are spreading and the growth rates of the urban population are significantly higher than the average growth rate of the whole population.

When individuals or families leave for good, remittances might be sent for a shorter or longer time span to those left behind, but as a rule they tend to decline and eventually dry out. How this process develops, depends on the economic and cultural context.

Sending remittances to secure the survival of the family/household left behind is, for example, less common for internal settlement migration in the social context of Latin America. Therefore, the implications of out-migration from overpopulated regions are quite different from those described above. They are analysed by Müller (1993) for the Valle Grande in Bolivia, a smallholder region characterised by long-term net population loss, selective out-migration and no significant remittances received from those who have out-migrated. 76% of the population of Valle Grande live in rural areas where non-agricultural sources of income are largely lacking. With the applied techniques, only 10% of the province area can be cultivated by field crops. Over the past

decades the region was hit by repeated periods of drought. Desertification is accelerated by deforestation and soil erosion which is mainly due to cattle holding in unregulated pasture economies.

Between 1950 and 1992, the Valle Grande lost 20% of its population by out-migration. Out-migration is promoted by the fact that the Valle Grandinos dispose over alternatives to agriculture for gaining an income. Traditionally they are engaged in trade and transport. Under these conditions, they have concentrated less on agricultural innovations to improve their farms.

Out-migration seems to bear a negative ecological impact. It has not lead to a reduction in the number of cattle kept, but only to a stronger concentration of cattle holding. In addition, deforestation has accelerated due to a lack of labour force. As the fields weed up extremely rapidly, and herbicides are very expensive as compared to labour, it is more profitable for the farmers to burn down forest areas to gain new fields than weeding old ones. This development has resulted in increasing desertification.

In addition, out-migration has brought a permanent erosion of the region's productive human capital. The major reason is that out-migrants tend to be the younger and more productive persons, while the weaker sections of the population stay behind. As the better qualified leave, more demanding jobs cannot be filled adequately, neither in the private sector nor in the provincial administration. As this pattern has persisted over decades, social problems, like over-ageing of the population, high dependency rates, alcoholism and high suicide rates prevail.

As unfavourable areas are increasingly emptying and isolated, critical numbers of inhabitants for maintaining the public infrastructure in many places do not exist anymore, which provides further incentives for out-migration.

Declining productivity has been particularly pronounced in agriculture. For almost all crops for which Valle Grande once had an almost monopolistic standing, like maize, land productivity has fallen far beyond the average of the departamento and the country.

Out-migration hence has lead to an erosion of the physical as well as the human resources. As a result, the region suffers from a steep economic and social decline. Life expectancy is below and child mortality is above the Bolivian average. As the economic potential of the region has dramatically declined, the remaining populations finds it increasingly difficult to maintain itself.

A case of involuntarily permanent out-migration from an arid region hit by desertification is described by Randall (Randall 1998). In her study she demonstrates for the Malian Gourma that traditionally based strategies to temporarily escape from drought can end up in permanent displacement, the loss of the traditional socio-economic life style people and, as a result, accelerating degradation of the region's natural resources and desertification, if too much physical and social capital is lost. „...both those maintaining a nomadic lifestyle and those who have migrated to towns are modifying their use of natural resources in ways which are inevitably likely to increase demand and probably lead to over exploitation. The very basis of existence in the arid rural region cannot go back because no more resources are available.,, (Randall 1998:172). The loss of herds is the key to this development. „Unfortunately, human

exploitation is probably less controlled than animal numbers and poverty is leading both rural and peri-urban populations to depend more and more on the only 'free' resources around" (Randall 1998:172).

An important but largely neglected aspect to consider when asking for the impact of out-migration on the carrying capacity of arid regions is the fact that the maintenance of irrigation systems often requires a certain social organisation of the population in the region. When this social organisation is disturbed, such systems tend to collapse, and, as a consequence, desertification accelerates. Such a situation is described, e.g. by Amini for desert border regions of Iran, where the flight from the countryside and the depopulation of numerous villages entailed a drop in the number of ecologically very important „qanat,, irrigation systems, and their replacement by deep wells, all of which led to the desertification of wide areas (Amini 1999).

### **International migration: a special case**

Strategies of labour export from arid regions are also pursued on a large scale at the international level, often actively supported by governments. Arid countries are among the world's major labour exporting countries, and it is a striking fact that those arid countries which are not in a position to earn a significant amount of their foreign exchange by oil exports are labour exporters<sup>3</sup>. In these countries, remittances are so high that they have a significant, and in many cases a dominant, influence on the macro-economic development of the whole country<sup>4</sup>. In 1998, Egypt received an amount of US\$ 4.360 bio. and in 1997 US\$ 4.528 bio. as workers' remittances, which is equal to a per capita receipt of US\$ 71.0, resp. 75.14 per capita of the population<sup>5</sup>.

This amounts to more than 10% of the country's GDP and about 25% of its export earnings in 1998. These official figures still underestimate the total amount of remittances coming into the country, as much of the money earned abroad is sent back or brought back through informal channels. According to estimates by Adams for the period 1985 to 1986, almost one-third of the total remittances entered the country without being registered officially (Adams 1991). In spite of its still high significance for Egypt's economy, remittances have been declining. Ten years before, in 1987, they still amounted to US\$ 9.807 bio.

For the households involved in international migration to high income industrialised and/or capital rich countries, like the U.S., Saudi Arabia or France, the monetary gain from migration is so large that their reactions and the consequences resulting from this differ significantly from those of intra-national migration or migration to poor neighbouring countries. Therefore, this form of migration requires separate consideration.

Most often, international migration is so profitable for the households that remittances exceed all other sources of income. Against that background, it is not unusual for regions of international out-migration that agricultural productivity declines because a large part of the younger male labour force is absent for a longer span of time, and

<sup>3</sup> Labour exporting countries are defined as those who receive more than 50% of their foreign exchange through migrants' remittances (Knerr 1998b).

<sup>4</sup> For details see Knerr 1998b

<sup>5</sup> Calculated with data from the World Bank (World Bank 2000). Remittances can be calculated there as the category „net current transfers from abroad“.

remittances are hardly spent on productive farm investment. Striking examples to this are Yemen (Knerr 1998b), the Mexican province of Zacatécas (Moctezuma 1999), and Pakistan (Knerr 1998b, Batzlen 2000). Typical investment categories are houses, furniture and vehicles, and in some regions, as, e.g. Pakistan, the marriage of the migrant himself, his brothers and sisters (Batzlen 2000). The last investment category might be quite rational from the individual point of view as it provides a social safety net which might be helpful in adverse situations in a hostile environment. A similar pattern has been observed by Reichert in his case study on six Egyptian villages, where the major specific motivations and goals of international migrants were building or rebuilding a house and marriage (Reichert 1993).

## Conclusions

The above analysis demonstrates that predicting the impact of migratory movements from and within arid regions by applying the results of theoretical models may be misleading. It demonstrates that for rational reasons migration strategies might be chosen which further accelerate desertification and the erosion of the natural resources.

Against the background of an urgent need for information on which policy action can be based, it is strongly recommended that results obtained from case studies are immediately fed back into the political discussion process, both on the national and on the international level. Development policies which do not take these experiences into consideration might lead to unexpected and undesired results. The existing interactions between desertification and migration, combined with a lack of knowledge, call for co-operation on the scientific as well as on the political level.

There is an urgent need for research about internal migration in Egypt, its dimensions, causes and consequences. Within this context, making use of experiences made and results obtained by joining international scientific co-operation are essential. In return, further investigations in Egypt could provide valuable information for other arid regions faced by similar problems.

International co-operation might also include technical and financial support by the population of those states which are economically and ecologically better off, but which are equally negatively effected in their well-being when desertification proceeds world-wide, and migratory movements extend to refugee movements of those who are no long able to make a living in their arid home region.

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## **University Staff Development (Group Papyrus)**

### **International university cooperation at the University of Göttingen**

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Der unter diesem Titel angekündigte Vortrag wurde auf Wunsch der Teilnehmer nicht wie geplant in englischer sondern in deutscher Sprache präsentiert.

Ziel des Referates war, den besonderen Stellenwert von internationalen Hochschulkooperationen am Beispiel der Universität Göttingen vorzustellen. Anhand von vier zentralen Fragen erläutert die Referentin das Thema.

#### **Was versteht man unter Universitätskooperationen ?**

Wichtig ist, die verschiedenen Ebenen wissenschaftlicher Zusammenarbeit zwischen Universitäten im Blick zu haben, sowohl Kontakte

- auf Instituts – bzw. Seminarebene,
- auf Fakultäts- bzw. Fachbereichsebene und
- auf gesamtuniversitärer Ebene unter Beteiligung mehrerer Fachrichtungen.

Die Zusammenarbeit kann ganz unterschiedliche Schwerpunkte umfassen im Bereich von Lehre, Forschung und/oder Wissenstransfer. Die gegenseitigen Verpflichtungen sind sehr unterschiedlich weitreichend je nachdem ob z. B. Dozenten – und / oder Studierendenaustausch vereinbart ist, die gemeinsame Entwicklung von Curricula oder die gemeinsame Durchführung von Forschungsprojekten.

Die Datenbank „Internationale Hochschulkooperationen“ der Universität Göttingen enthält z. Zt. Grundinformationen über ca. 1.300 Kooperationsvereinbarungen, wobei der größte Anteil Kontakte zwischen Hochschullehrern auf Instituts- bzw. Fakultäts-ebene betrifft. Die Zahl der fächerübergreifenden Partnerschaften auf gesamtuniversitärer Ebene ist demgegenüber sehr niedrig und liegt momentan bei ca. 30 Programmen.

#### **Welche Kriterien gibt es für gute Kooperationsprogramme ?**

Hier werden sechs Gesichtspunkte näher erläutert:

- wie passt die geplante Zusammenarbeit in die Lehr- und Forschungssituation der beteiligten Partneruniversitäten,
- wie detailliert sind die jeweiligen Arbeitspläne und Besuchsprogramme,
- wie genau sind die gemeinsam entwickelten mittel- und langfristigen Ziele und Perspektiven abgestimmt,
- wie verbindlich sind die vereinbarten Qualitätsstandards der beteiligten Hochschulen, welche Evaluationsprogramme greifen,
- wie klar sind die Verantwortlichkeiten geregelt, z B. über „Beauftragte für die Kooperation“, die die beteiligten Hochschulen jeweils selbst benennen,
- wie kontinuierlich gestaltet sich die Zusammenarbeit (regelmäßige Berichte, Finanzierungsanträge und Öffentlichkeitsarbeit).

**Wie werden Universitätskooperationen aufgebaut ?**

Anhand von verschiedenen Beispielen wird ausgeführt, dass sich in der Regel die Programme besonders erfolgreich und lebendig entwickeln, die aufgrund des besonderen persönlichen Engagements einzelner Hochschullehrer entstehen.

Die Stationen über Förderungsmaßnahmen, Erweiterung durch zusätzliche Fachrichtungen und die Einbeziehung administrativer Hilfen werden skizziert.

**Welche Rahmenbedingungen sind hilfreich für die Kontinuität von Universitätskooperationen ?**

Abschließend werden hier wichtige Faktoren der Zusammenarbeit zwischen Hochschullehrern und Verwaltungsstellen erläutert und Anregungen gegeben zur möglichen Rolle von Alumni (Absolventen der jeweiligen beteiligten Universitäten).

## **Reform of higher education in agriculture in Göttingen (Germany): Reorganization, modularization and internalization of the curriculum**

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Traditionally, agricultural sciences are standing in a wide-spread international context: agricultural research is conducted world-wide, scientists exchange expertise between countries and continents, and an exchange of scientists as well as study abroad and student's exchange have become an important part of higher education in agriculture. Many graduates with a degree in agriculture are applying for a job abroad.

The conventional education system at German agricultural faculties bore some difficulties for the acceptance of German graduates at international job markets as well as for an uncomplicated international students exchange. The traditional German „Agricultural Engineer“ degree program (the so-called „Diplom“) is designed to last four and a half years in a rather rigid, subject-based course design where a given subject may stretch over a time period of up to one and a half years before exams are held. Another problem is a lack of compatibility of the German Diplom with common international university degrees especially in anglo-american education systems.

Thus, in the last years the internationalization of agricultural study programs has become widely desired amongst German universities with degree programs in agriculture. To force the reform process, the German government (BLK – Bund-Laender-Kommission) established a model project with four partner institutions (the Universities of Hohenheim, Kiel and Goettingen and the Neubrandenburg University of Applied Sciences) which are working in close cooperation on the reform of their agricultural study courses. Main objective of the project is to improve the national and international competitiveness of the agricultural courses of study and to strengthen the individual profile of each partner institution. The most important instruments for this purpose are the modularization of the curriculum, the introduction of Bachelor and Master degrees and the offer of modern focal points during the study of agricultural sciences.

With the beginning of winter semester 1998/99 the Faculty of Agricultural Sciences at Goettingen University has realized the reform of the study system by replacing the old „Diplom“-system by the so-called modular system and the introduction of B.Sc. and M.Sc. degrees. The modularization process implied the introduction of smaller, more flexible units of teaching and examination. The partner Universities within the BLK-project have agreed to strive for similiar module sizes. A module is based on 60 contact hours, amounting to 180 hours of workload and 6 ECTS (European Credit Transfer System) credits. Modules last only one semester and are examined before the following semester begins.

This modularized course structure has several advantages compared to the old subject-based system: Modularization leads to a significant reduction of the actual duration of individual study courses. Because of the rather long actual duration of study courses compared to the international standard this has become an important

political objective in Germany. Different modules can be combined like bricks in a building set, which allows for a more flexible organization of an individual's course of study and thus to the acquisition of an individual profile which is well documented in the transcript of records.

Modularization and the introduction of a credit point system leads to more flexibility and mobility for students as well as for training staff. Thus, it has become easier to accommodate courses taken at other universities in one's individual study program with full recognition of the learning achievement gained at national or international partner institutions. This means that no extra time has to be invested till the degree is completed.

The second important element of the study reform is the introduction of undergraduate and graduate level courses. The reorganized curriculum at Goettingen University now provides the B.Sc.-degree after three years of study (including a thesis work of six weeks duration) and the Master-degree after two more years (including a thesis work of six months duration). In the undergraduate level program students have to pass nineteen compulsory modules during the first two years of study. These modules impart a broad basic knowledge, including natural sciences like mathematics, chemistry and physics as well as the fundamentals of plant and animal production, agroecology, soil sciences, agroecology and agricultural engineering.

The B.Sc. program extends over two more semesters after the two years of basic study; in these two semesters students have to complete nine modules. The total number of contact hours for the B.Sc. is 1740 (1180 in the two basic years plus 560 in the B.Sc. programme). The M.Sc. program lasts over four semesters of in-depth studies consecutive to the B.Sc.. For the M.Sc.-degree nine more modules (with a total of 560 contact hours) and the master thesis have to be completed.

Bachelor- and Master-students have the possibility to choose between five majors: „Plant Production“, „Animal Production“, „Economics and Social Sciences in Agriculture“, „Agriculture and the Environment“ and „Agribusiness“. Additionally, a new Master program „International Agriculture“ in English language with focus on agriculture in the tropics and subtropics will start with the beginning of winter semester 2000/2001. The Bachelor- as well as the Master-Programs comprise a combination of compulsory and optional modules. The compulsory modules characterize the chosen major, the optional modules partially have to be selected out of a catalogue of modules for the majors and partially can be picked out of the whole faculty's offer, which includes a number of inter- or cross-disciplinary modules as well as different modules which are related to topics of international agricultural sciences. In the Master program two modules from other courses of study like biology, geography etc. can be integrated. As a consequence, students in Goettingen's Bachelor and Master programs are enabled to create a very individual qualification profile, according to actual professional requirements and prospects as well as to personal interests.

The introduction of a more flexible study structure, of international compatible undergraduate and graduate level degrees, a credit point system and modern majors in which relevant international aspects are considered is an important step towards better international compatibility of our agrarian study courses and towards higher mobility to the benefit of professional and personal enrichment. Our students are enabled to participate more in international student exchange programs, and we hope for more foreign students to study at Goettingen University where they will learn about a different country, language and culture and are enabled to combine their studies with professional and scientific experience on a high scientific level.

## University Staff Development Programme

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### Einleitung

In der letzten Dekade sind eine Reihe von Überlegungen angestellt worden, um die Rolle der Hochschulbildung im Allgemeinen und die Rolle der Universitäten im Besonderen zu klären. Einige dieser Überlegungen wurden durch das Strategiepapier der World Bank „Higher Education: The Lessons of Experience“ (1994) vorgestellt. Weitere Überlegungen kamen aus der Weltkonferenz „On Higher Education“ von 1998. Eine mehr oder weniger einflussreiche Abhandlung zu diesem Thema war Michael Gibbons Studie (1994) „The New Production of Knowledge“. Eine der wichtigsten Unterlagen hierzu war „The World Declaration on Education for All“ und „A Framework for Action to Meet Basic Learning Needs“ in Verbindung mit der „World Conference on Education for All“ (1990).

In diesen und weiteren wichtigen Abhandlungen ging es vor allem auch um die Frage der notwendigen Veränderungen im Hochschulbereich weltweit. Diese Veränderungen jedoch erfordern grundlegende strukturelle Analysen des *status quo* in den Universitäten. Hierzu gehört eine Analyse des Standpunktes des Hochschulpersonals und seine Vorbereitung auf die Übernahme der Trägerschaft bei diesen Veränderungen, die als Gegenstand dieser Abhandlung diskutiert wird.

### Bedarf für Veränderungen

In allen diesen Debatten der letzten Dekade werden einige Punkte besonders hervorgehoben:

- Universitäten weltweit befinden sich aufgrund ihres neuen Rollenverständnisses entweder jetzt schon in einem Prozeß der Veränderung oder werden in naher Zukunft mit den Forderungen nach Veränderungen konfrontiert
- Das Überleben der Universitäten hängt stark von dem Willen ab, diese Forderungen nach Veränderungen nicht nur zu verstehen, sondern sie auch mittel- und langfristig umzusetzen
- Internationalisierungs- und Globalisierungstendenzen setzen die Wirtschaft und Wissenschaft unter starken Zugzwang, zu diesen Forderungen nach Veränderung Position zu beziehen
- Die Universitäten befinden sich in einer allgemeinen finanziellen Krise im Hinblick auf die Effizienz, Konkurrenz und Zusammenarbeit mit anderen gesellschaftlichen Institutionen
- Die Unterstützung der Universitäten durch den Staat wird tendenziell zu Gunsten von Autonomie und Selbständigkeit aufgegeben
- Der Paradigmenwechsel in der Hochschullehre, Hochschulforschung und Hochschulorganisation hat inzwischen in vielen Bereichen der Universitäten bereits stattgefunden.

Damit die Universitäten ihre Qualität sichern, ihre Effizienz durch Konkurrenz und Kooperation erhöhen können, brauchen sie die Erlangung einer Autonomie in allen akademischen Angelegenheiten und infolgedessen die Förderung der Selbstorganisation (Self-Management) als Gegenposition zu staatlicher Kontrolle und Führung.

Universitäten mit staatlicher Führung und Kontrolle mußten sich bislang nur wenig um organisatorische Veränderungen kümmern, sondern haben lediglich auf die staatlichen Beschlüsse und Interventionen reagiert. Ebenso wenig war es bisher möglich oder gar notwendig, die Effizienz des Curriculums, der Lehre, der Forschung und schließlich der Administration zu verbessern.

Mit der Förderung der akademischen Selbstorganisation verbindet sich die Frage der Weiter- und Fortbildung des in der Hochschule tätigen Personals. Die Fortbildung soll helfen, die Aktivitäten einzelner Mitglieder in der Hochschule entweder analog zu den anstehenden Veränderungen in der Hochschule optimal zu organisieren oder sie gerade für die Veränderungen zu mobilisieren. In diesem Sinne bezieht sich die Weiterbildung auf vier wesentliche Bereiche:

- Weiterbildung im Bereich des Lehrens und Lernens, inkl. Curriculumentwicklung und Evaluation
- Weiterbildung im Bereich der Forschungsplanung und des Forschungsmanagement
- Weiterbildung im Bereich der Hochschulorganisation und –administration
- Weiterbildung im Bereich der Extra-murus-Aktivitäten, inkl. Consulting und Beratung
- Weiterbildung im Bereich des Lehrens und Lernens

In der internationalen Diskussion werden die Veränderungen im Bereich des Lehrens und Lernens in den fünf folgenden Punkten zusammengefasst (Wessler, 1999):

Der Übergang vom Lehren zum Lernen:

- Für lange Zeit war das Augenmerk auf die Förderung der Lehre gerichtet. Heute wissen wir, dass es nicht nur darum geht, wie gelehrt, sondern eher, wie gelernt werden soll. Entsprechend konzentrieren sich unsere Überlegungen auf die Prozesse des Lernens, die Ergebnisse und die Resultate. Von der Lehre der Dozenten zum Lernen der Studenten; von den Instruktionen zu den Lernparadigmen.
- Der Übergang vom Lernen zum Wissen, vom Lernen zum Anwenden, vom Sein zum Zusammensein (UNESCO), inkl. Meta-kognitives und emotionales Lernen: Angesichts der Halbwertszeit des relevanten Wissens (für Ingenieurwissenschaften 3 Jahre) stellt sich die Frage der nach Validität des reinen Wissens auch angesichts der strukturellen Veränderungen des Arbeitsmarktes. Entsprechend wächst die Bedeutung der Schlüsselqualifikationen im Sinne des Lernens zum Lernen.
- Der Übergang vom prüfungsorientierten Curriculum zum professionalisierungsorientierten Curriculum: Um die Verantwortung für Wirtschaft und Gesellschaft sowie für die Umwelt übernehmen zu können, brauchen die Universitäten Zusatzprogramme jenseits der traditionellen Vermittlung vom Wissen innerhalb der Ausbildung.
- Der Übergang von personenorientierten Lehren und Lernen zum systemischen Lehren und Lernen: Dieser erfordert die Hinzunahme der neuen Medien und Technologien zum Zwecke eines effizienten Transfers von Wissen und Technologie.

- Der Übergang vom individuellen Lernen zum gemeinsamen Lernen: Individuen lernen nur im engen spezifischen sozialen und institutionellen Umfeld. Um diese Art des Lernens zu einem nachhaltigen und gesellschaftlich relevanten Lernen zu erweitern, bedarf es der Einführung von Gruppenlernen und organisatorischem Lernen.

Nach Wesseler (1999) erfordert die Lehre als ein Prozeß, der die schöpferischen Potentiale anspricht:

- Ein Bewußtsein über die Wissenschaft, die vermittelt werden soll
- Eine Übersicht über die Relevanz dieser Wissenschaft in einem weiteren Kontext
- Eine Einbeziehung der Erwartungen der Studierenden
- Eine Anstrengung zur Herstellung einer Verbindung der Wissenschaft und menschlichen Potentiale wie Emotionen, Kreativität und gar Macht
- Eine Evaluation der Lehr-Lern-Erfahrungen mit den Studierenden und Kollegen

### **Weiterbildung im Bereich der Hochschulorganisation**

Eine Universität ist nicht eine einfache Zusammensetzung von Lehrenden mit den Aufgaben der Lehre und Forschung und Studierenden, die lernen, sondern sie ist ein System mit vielfältigen Verbindungen und Interaktionen zwischen seinen Elementen. Das komplexe System Universität zeichnet sich durch eine besondere Organisationsform, die Fremerey (1999) in Anlehnung an Weick (1976) folgendermaßen charakterisiert:

- Relativ geringe Koordination
- Relativ geringe Regelung
- Unübersichtliche Aktivitäten
- Existenz von Unabhängigkeiten
- Fehlende Rückkoppelung zwischen Ergebnissen und Input.

Dazu kommt noch die Schwerfälligkeit der Universitäten, strukturelle Veränderungen im Sinne einer „lernenden Organisation“ durchzuführen. Eine „lernende Organisation“ zeichnet sich aus durch die Definition einer gemeinsamen Vision, Einführung einer synergetischen Führung, Akzeptanz einer vielfältigen Realität, Umgang mit Konflikten und Widerständen und schliesslich durch die Einbeziehung vom gemeinsamen Lernen (Team Learning). Eine lernende Organisation ist in der Lage, nicht nur ihre Kapazitäten ständig zu erweitern, sondern auch fähig, ihre Zukunft zu planen (vgl. Fremerey, 1999). Die Identifizierung und Feststellung dieser Notwendigkeiten und die Bewältigung von grundlegenden Hemmnissen für eine sinnvolle Veränderung sind selbst wichtige Prozesse des gemeinsamen Lernens im Sinne der Verbesserung der Effektivität, der Effizienz, Nachhaltigkeit und Verantwortlichkeit innerhalb der Universitäten. Nach Teichler sind Universitäten im Hinblick auf ihre Struktur auf Gestaltebene sowie auf politischer, organisatorischer und funktionaler Ebene zu analysieren und zu vergleichen. Diese Ebenen beziehen sich auf eine Vielfalt von Faktoren, die als ganzes das Wesen des Bildungssystems ausmachen.

### **Weiterbildung im Bereich der Forschung**

Veränderungen im Bereich der Lehre und Organisation gehen Hand in Hand mit der Organisation und dem Management im Bereich der Forschung. Das Problem der Forschung in den Universitäten wird in den folgenden Bereichen diskutiert (Amini, 1999):

- Die Qualifikationsfrage für die Durchführung von Forschung in der Hochschule
- Die Forschungspolitik auf unterschiedlichen Ebenen (international, national, regional und universitär)
- Forschungsmanagement im Sinne der Konzipierung, Planung und Durchführung von Forschungsarbeiten, inkl. Finanz-, Personal- und Zeitplanung
- Verbindung zwischen Lehre und Forschung
- Fort- und Weiterbildung vom Forschungspersonal sowohl inhaltlich als auch methodologisch
- Interne und externe Kommunikationsformen und Interaktionen.

Diese Aspekte werden insbesondere in Verbindung mit anstehenden künftigen Veränderungen der Universitäten relevant. Eine wichtige Frage des Forschungsmanagements wird in Verbindung mit der finanziellen Autonomie der Hochschulen besonders sichtbar. Hier werden feste Zuwendungen der Universität für die Forschung durch die Möglichkeiten der Verbindung mit den Förderinstitutionen zum Zwecke der Akquisition der Drittmittel ersetzt. Logischerweise werden dann nur diejenigen Forschungskonzepte zum Tragen kommen, die sowohl im Hinblick auf die Qualität als auch im Hinblick auf Relevanz, Aktualität und Originalität besser beurteilt werden können. Außerdem erfordern die Forschungsarbeiten die rechtzeitige Vorstellung der Resultate in Form von Forschungsberichten und Publikationen.

Die effiziente Gestaltung der Forschung bezieht sich auf die Organisation interner und externer Kommunikationsformen: Diese sind Verbindungen zwischen Lehre und Forschung, Forschung und Karriereplanung, Forschung und Entwicklung, Forschung und Verwaltung und schliesslich Forschung und Hochschulorganisation.

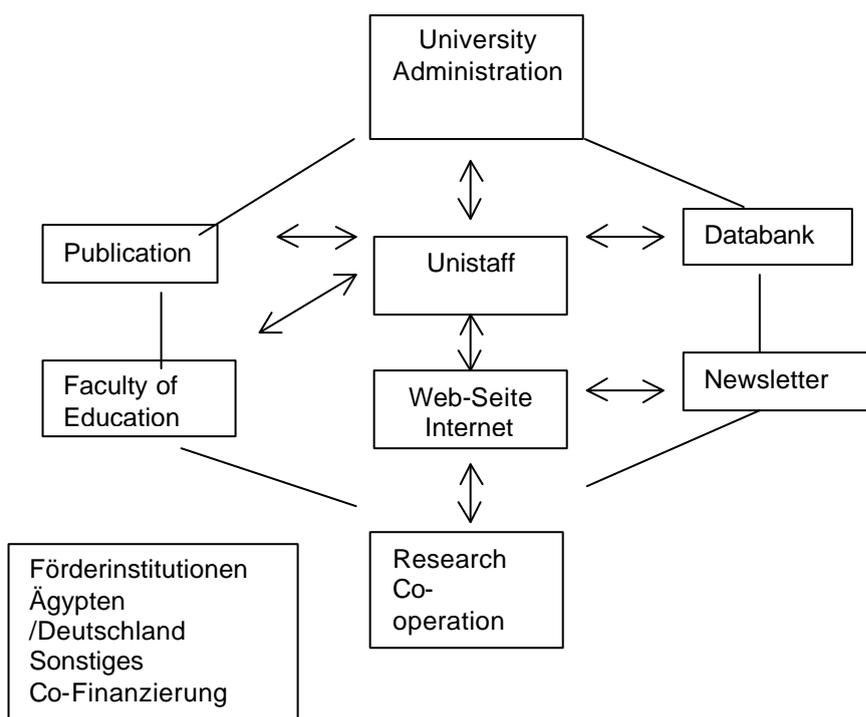
### **Notwendigkeit der lokalen Einheiten „UNISTAFF“**

Auf der Basis lokaler Erfordernisse (Need Assessments) ist die Gründung lokaler Einheiten in den Universitäten für eine Neugestaltung der o.g. Bereiche notwendig, um das Hochschulpersonal kontinuierlich mit den neuesten Erkenntnissen der Lehre, Forschung und Administration in Hochschulwesen zu konfrontieren. Eine solche Einheit (UNISTAFF) arbeitet hauptsächlich mit folgenden Zielen:

- Analyse und Bewertung der Verbindung zwischen Lehre und Forschung einerseits und zwischen Hochschule und gesellschaftlichen Institutionen andererseits
- Planung und Entwicklung relevanter Curricula
- Entwurf von Modellen und Ansätze für die Lehre und Forschung
- Kontinuierliche Evaluation der Aktivitäten und Institutionen
- Konzipierung und Planung von Hochschulforschung
- Management von Universität und Universitätsinstitutionen sowie Organisationsentwicklung

Die Voraussetzungen der Gründung lokaler „University Staff Development Programme“ in den Universitäten sind:

1. Die Analyse und Bewertung derzeitiger Universitätsstrukturen hinsichtlich der politischen, funktionalen und organisatorischen Zusammenhänge,
2. Eine Bedarfsanalyse für die Gründung der lokalen Einheit zum Zwecke der Förderung der Fort- und Weiterbildung des Hochschulpersonals auch aus der Sicht der verantwortlichen Personen (Präsidenten, Verwaltung, Fachbereiche und Institute),
3. Entwicklung eines relevanten Curriculums für die lokale Einheit, inkl. Zielsetzung, Dauer, Lehrpersonal, Zielgruppe, Medien und Resultate.



Eine vorläufige Organisation des lokalen UNISTAFF für die ägyptische Situation wird in der o.a. graphischen Darstellung gezeigt. Folgende Ziele wurden auf dem Symposium-cum-Workshop im November 1999 von einer speziellen Unistaff-Gruppe herausgearbeitet:

- Förderung der neuen Methoden des Lehrens und Lernens an ägyptischen Universitäten
- Förderung der individuellen und gemeinsamen Forschungsvorhaben durch die Vermittlung von Forschungspolitik und Forschungsstrategien in Ägypten und auf internationaler Ebene
- Förderung der Ausbildung junger Wissenschaftler durch gezieltes Training
- Vorbereitung der Staff-members auf Änderungen im ägyptischen Hochschulbildungssystem
- Förderung der Kooperation und Kommunikation zwischen ägyptischen und ausländischen Wissenschaftlern.

Die möglichen Inhalte der Module wurden ebenfalls auf der Tagung im November diskutiert.

- Analyse und Beurteilung der Zusammenhänge im ägyptischen Bildungssystem und deren Wirkung auf die Aktivitäten der Hochschullehrer / Studenten u.a.
- Lehren und Lernen an ägyptischen Universitäten und Probleme der Anwendung neuer Lehr- und Lernmethoden / Evaluation
- Konzipierung und Durchführung von Forschungsvorhaben (jetzt u. in der Zukunft). Forschungspolitik und Strategien/ Ressourcen, inklusive internationale Kooperation / Publikationen.
- Neue angepasste Problemstellungen
- Hochschulorganisation an ägyptischen Universitäten (Förderung /Hinderung).
- Kommunikation zw. Hochschuladministration und Lehre & Forschung

- Probleme der Betreuung von Studierenden (Tutorien / große Klassen); studentische Beteiligung (Vor- und Nachteile) Absolventen/innen Probleme
- Förderung der Verbindung zw. Hochschule, Universitäten mit der sozialen und physikalischen Umwelt (Ökologie). Consultancy; Extra-mural activities

### **Bedarf für die Zusammenarbeit und Kooperation**

Es ist evident, daß eine solche lokale Einheit von der internationalen Kooperation weitgehend profitieren kann. Auf der einen Seite sind Kooperationen im Hinblick auf den Austausch von Erkenntnissen im Bereich der Fort- und Weiterbildung auf der internationalen Ebene notwendig, auf der anderen Seite jedoch sind Kooperationen im Bereich der Nutzung vorhandener personeller und finanzieller Ressourcen unabdingbar, vor allem dann, wenn weitgehend ein Mangel geschulter Lehrkörper besteht.

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## **Subject related partnership between the Universities of Göttingen (Germany) and Chiang Mai (Thailand)**

### **The area of academic co-operation in teaching and research mainly in the field of agriculture in the tropics 1998-1999\***

U. ter Meulen<sup>1</sup> G. Thinggaard<sup>1</sup> and T. Vearasilp<sup>2</sup>

#### **General objectives of the DAAD grant programme**

The objectives of this Grant-Programme is to stimulate and strengthen university collaboration for development. In particular, the following objectives are aimed for:

- Further raising of the standards of universities in developing countries in their teaching, research, services and management methods („institutional development“)
- Stabilising partnerships between universities made possible through grants over several years, which in turn permits long-term institutional ties;
- Furthering the education and training of the participating members of the universities in the developing countries (professors, junior faculty, graduate students, undergraduate students), and promoting experience of international co-operation;
- Creating networks between German universities and their partner institutions;
- Enhancing the attraction of German universities and strengthening Germany's position as an international centre for research.

#### **The partnership programme between Göttingen and Chiang Mai**

Based on the above described objectives of the DAAD partnership programme, a project proposal for a partnership programme between the Universities of Göttingen, Germany and Chiang Mai, Thailand was prepared and granted in 1998, the Partnership Agreement between the Universities was signed and the activities foreseen in the plan of operation started.

#### **Activities during the first two years:**

**Target 1:** Through subject related co-operation in teaching, the academic quality in the present Agricultural Science Programme at the Chiang Mai University will benefit positively.

A Seminar was conducted, papers presented at 2 Conferences and 10 Lectures given at the Chiang Mai University by 3 Professors from Göttingen University.

**Target 2:** The entrance of Thai students with appropriate B.Sc. qualifications into the Masters Programme at the University of Göttingen will be supported.

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\*) programme of the German Academic Exchange Service (DAAD), Bonn, Germany

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<sup>2</sup>Department of Animal Science, Faculty of Agriculture, Chiang Mai University, Thailand

The Faculty of Agriculture, Göttingen University, has 1999 revised their educational system to fit into international standards and introduced the B.Sc. and M.Sc. degrees additional to the German „Diploma“ degree. Students with a B.Sc. degree with a minimum pass of not less than 2.5 can enter the M.Sc. Programme.

**Target 3:** A mutual recognition of credits are achieved.

Up to now only Chiang Mai University had a credit system. Göttingen is presently changing it's system to make it international compatible. In 1999 the new „module system“ was introduced in Göttingen, this allows for mutual recognition of credits.

**Target 4:** The University of Göttingen recognise the M.Sc. certificates obtained at the Thai Faculties of Agricultural Science for Ph.D. studies.

The Curricula of the Faculty of Agriculture, Chiang Mai University was translated into English to enable comparison with the corresponding German curricula. A recognition of the Thai M.Sc. degree was obtained by the Faculty of Agriculture Science in Göttingen, which means that Thai agriculture students now can enter the Ph.D. programme in Göttingen on same terms as German students (a M.Sc. degree with a minimum pass of not less than 2.5 and not as previously after two entrance exams). Through the obtained recognition of the Thai M.Sc. certificate, the Ph.D. study period is reduced by 6 months. Through application, a dissertation in English language can be approved.

**Target 5:** The M.Sc. programme in „Agricultural Sciences in the Tropics and Sub-Tropics“ at Göttingen University is improved through lectures by visiting Thai University lecturers as well as through the possibility for practical experience in Thailand.

To prepare the German graduate for a job activity in international agricultural institutions or in development projects, applicatory lessons are advantageous. To that effect, lectures from Thai lecturers in chosen areas of practical relevance are offered. 2 papers were presented at Tropentag in Göttingen and 15 Lectures given at the Göttingen University by 7 Professors from Chiang Mai University.

**Target 6:** In order to create a wide contact base, an exchange of scientists and students is supported.

To exchange information on actual research and running projects, Thai scientists and students are invited to take part in the „Colloquium for Tropical Animal Production“ at the University of Göttingen. In order to get the research results published, it is intended that Thai scientists regularly participate in the „Tropentag“, a joint annual seminar on tropical issues of the Universities of Göttingen, Hohenheim and Berlin. For the German scientists, corresponding presentations of research projects in Thailand is planned.

During the first two years, 7 Thai university teachers visited Göttingen, and 3 graduate Thai students took up their studies in Göttingen. 3 German university teachers, 2 scientific staffmembers and 2 students went to Chiang Mai.

A bilateral research project on trout raising was implemented under the Kings Projects at Doi Internon National Park. Trout eggs were supported from Germany and together scientific staff of Germany and Thailand try to find the best way to raise trout under tropical conditions.

Altogether 9 posters on joint research were presented at the „Tropentag“ in 1998 in Göttingen and 1999 in Berlin. The Research results were published in the respective Seminar Publications.

## ***Irrigation (Group Nile)***

### **Water, Irrigation and Food Supply - a Keynote Address**

Prof. Dr. Peter Wolff

Witzenhausen  
Germany

#### **The challenge**

The present 6 billion world population is projected to increase to 9 billion over the next 50 years with an estimated 95% of the growth taking place in developing countries. The associated increase in food requirements coupled with increasing constraints on available water and land resources presents a tremendous challenge for present generations working to overcome poverty in less-developed countries without compromising living conditions for future generations. The increasing demand for food will occur at the same time as a large part of the world population suffers from food shortages and heavy malnutrition. Much of the required increase in food production over the next 30 years will be in developing countries.

Land and water resources play a major role in increasing food production. But land and water resources are limited. Land degradation in the developing countries is increasing rapidly. A large part of rainfed agriculture is already extremely vulnerable to drought, soil loss, declining soil fertility, and disruption of water resources. Many of the agrosystems are ecologically fragile and require soil and water conservation measures and techniques to prevent degradation and maintain yield potentials. Land resources in irrigated and potentially irrigated areas also suffer from mismanagement, flood hazards and salinization.

Water is abundant globally but scarce locally. Of the earth's 1,360 million cubic kilometres of water, 97 percent is in the oceans. Three quarters of the freshwater is in glaciers and icebergs, another fifth is groundwater, and less than 1 percent is in lakes and rivers. Almost two-thirds of the renewable freshwater provided by annual rainfall over land evaporates. Much of the rainfall transformed into runoff is lost to floods. Given current global water use of 4,000 cubic kilometres, the remaining 14,000 cubic kilometres of effective runoff would be adequate to meet demand for the foreseeable future if supplies were distributed equally across the world's population. But freshwater is distributed extremely unevenly across countries, across regions within countries, and across seasons.

Fortunately, there is a potential for expanding food production. Actual cereal yields in the developed countries is now over 4 t/ha, while in developing countries it is only 2.3 t/ha. Irrigated land accounts for 18% of the cultivated land, but produces 33% of the world's food supplies. It is expected by Pereira et al. (1996) that appropriate intensification and expansion of irrigated areas may account for more than 50% of food requirements by the year 2025. Thus, to meet the expanding food demand there is a need for increasing the average yields and a need for irrigated agriculture.

Water resources play a major role in expanding irrigated agriculture and associated food production. Existing technologies and management techniques for improved water utilisation in agriculture will play an important role in meeting the enormous challenge of population growth and increased food demand. Because of this challenge research efforts have to be increased. There is especially a need to redirect research to fully meet the requirements of sustainable land and water resources utilisation in agriculture. This research and associated information transfer should lead to technologies that would conserve the natural resources, land, and water in particular, and be environmentally nondegrading, technically appropriate, economically viable, and socially acceptable.

## **Water**

The water crisis, which some arid and semi-arid countries are facing already for some time and which more and more other countries will start to face as we enter the 21st century, can be according to Biwas (1991) considered to be the direct result of four important but interrelated phenomena.

First, the amount of fresh water available to any country on a long-term basis is limited. Since nearly all the easily available sources of water have more or less been developed or are in the process of development, the unit costs of future projects can only be higher.

Second, world population is increasing steadily, in some parts of the world even dramatically. Consequently, water requirements for domestic, agricultural and industrial purposes and hydroelectric generation will increase as well. There is of course no one-to-one relationship between population and water requirements, but that the water requirements will increase that is for sure. In this connection we have to consider that past experiences indicate that as the standard of living increases, so do per capita water requirements. Hence, if the present poverty alleviation programmes succeed, both water requirements will increase further and the water management process must become significantly more sophisticated. These two facts have often not been considered by policy makers and planners, both nationally and internationally.

Third, as human activities increase, more and more waste products are contaminating available sources of water. These contaminants are seriously affecting the quality of water, especially for domestic use. They also restrict the amount of fresh water available.

The fourth major factor is the increasing delays that are likely to be witnessed in the coming decades to implement new water projects. Higher project costs and lack of investment funds will be two major reasons for this delay. Equally, social and environmental reasons will significantly delay project initiation time, certainly much more than what have been witnessed in the earlier decades.

There is no doubt according to Biwas (1991) that water requirements of developing countries will continue to increase significantly during the next several decades. However, the traditional response of increasing water availability to meet higher and higher water demands will no longer be adequate in the future for two important reasons:

- Many countries simply do not have any major additional sources of water to develop economically.
- Even those countries that may have additional sources of water, time periods required to implement those projects are likely to be much longer than expected at present.

Seckler et al. (1999) pointed out in a more recent publication that after thousands of years of human development in which water has been a plentiful resource in most areas, amounting virtually to a free good, the situation is at the beginning of the twenty-first century changing abruptly to the point where, particularly in the more arid regions of the world, water scarcity has become the single greatest threat to food security, human health and natural ecosystems.

Talking about water scarcity raises the question: When does water scarcity become a problem? Water analysts use the following rule of the thumb: countries with freshwater resources of 1,000 to 1,600 cubic meters per capita per year face water stress, with major problems occurring in drought years. Countries are considered water scarce when annual internal renewable water resources are less than 1,000 cubic meters per capita per year. Below this threshold, water availability is considered a severe constraint on socio-economic development and environmental quality. Currently, some 30 countries are considered water stressed, of which 20 are absolutely water scarce. By 2020, the number of water scarce countries will likely approach 35. Equally worrisome, virtually all developing countries, even those with adequate water in the aggregate, suffer from debilitating seasonal and regional shortages that urgently need to be addressed.

Analysing water scarcity in the next century Rosegrant (1995) identified the following challenges for the future:

**Low water use efficiency.** The foremost challenge related to water scarcity in developing countries is the need to increase generally inefficient water use in agriculture, urban areas, and industry. Irrigated area accounts for over two-thirds of world rice and wheat production, so growth in irrigated output per unit of land and water is essential. Improved efficiency in agricultural water use is required both to maintain productivity growth and to allow reallocation of water from agriculture to urban and industrial uses.

**Expensive new water.** New sources of water are increasingly expensive to exploit. Water to meet growing household and industrial demand may thus need to come increasingly from water savings from irrigated agriculture, which generally accounts for 80 percent of water diverted for use in developing countries. To truly contribute to reducing water scarcity, improved efficiency in urban and industrial use.

**Resource degradation.** The quality of land and water must be sustained in the face of mounting pressure to degrade these resources through waterlogging, salinization, groundwater mining, and water pollution.

**Water and health.** Pollution of water from industrial effluents, poorly treated sewage, and runoff of agricultural chemicals is a growing problem. Unsafe water, combined with poor household and community sanitary conditions, is a major contributor to disease and malnutrition, particularly among children. One billion people are without clean drinking water, and 1.7 billion have inadequate sanitation facilities. As many as

1 billion episodes of diarrhoea occur annually in developing countries. The World Bank has estimated that access to safe water and adequate sanitation could result in 2 million fewer deaths from diarrhoea among young children.

**Massive subsidies and distorted incentives.** Most of the world does not treat water as a scarce resource that it is. Both urban and rural water users receive massive subsidies on water use; irrigation water is essentially unpriced; in urban areas the price of water does not cover the cost of delivery; capital investment decisions in all sectors are divorced from management of the resource. In most countries, water subsidies go disproportionately to the better-off: irrigated farmers and urban water users connected to the public system. The inequity is exacerbated because subsidies are often financed from regressive taxes.

## Irrigation and food supply

One measure of the importance of irrigation as a factor in agricultural development is the share of food and agricultural output that is produced off irrigated Land (Yudelman, 1994). The Technical Advisory Committee (TAC) of the Consultative Group on International Agricultural Research (CGIAR) has estimated that between 1987 and 1989, the annual value of all crop production in the developing countries was around US\$364 billion. US\$104 billion worth of crops, that are 28.5% of the value of all production, was produced on irrigated land. More than 30% of all food production was grown under irrigation. Perhaps, irrigation's largest contribution to both consumers and producers is that an estimated 46.5% of all grain and 57% of the total value of the most widely grown basic staples (rice and wheat) were produced under irrigation.

On a regional basis, it is estimated according to Yudelman (1994) that around 60% of the value of crop production in Asia is grown on irrigated land. This includes about 80% of Pakistan's food, 70% of China's food and over 50% of the food of India and Indonesia. In the Middle East and North Africa, more than one third of the region's crop production by value is irrigated, including all food grown in Egypt and more than half of that grown in Iraq and Iran. A relatively small proportion of agricultural production in Latin America, around 10%, is grown under irrigation, but half of the crops grown for export in Chile and Peru are irrigated. Madagascar produces more than 20% of its agricultural output and food on irrigated land. Sub-Saharan Africa has the smallest regional area under irrigation, and produces an estimated 9% of its total food production of irrigated land (Yudelman, 1994).

The irrigated sector performs an essential task in meeting the basic food needs of billions of people in the world, especially in Asia. It has provided according to Yudelman (1994) more than half of the two most important basic staples and close to a third of all food crops. In the future, the irrigated sector will have to provide an even larger proportion of the total food output.

For most of modern history the world's irrigated area grew faster than the population. Since 1980 the irrigated area per person has declined and since the mid-1980s cereal grain production per capita has also declined.

The debate regarding the world's capacity to feed a growing population, brought to the fore in the writings of Malthus two centuries ago, continues unabated. But the growing

scarcity and competition for water adds an important element to this debate over food security. The eighteen percent of the world's cropland that is irrigated accounts for over a third of the food production. Fifty percent of the increase in food production over the past three decades has come from higher yields on an expanding irrigated land area.

Table 1. Estimates of values of food and agricultural crop production and percentages grown on irrigated land in developing countries 1988 - 89.

Crops	Value (US\$ billion)		Percentage grown on irrigated land
	Total	Irrigated	
All crops	364.2	104.1	28.5
Food crops	310.8	96.1	30.9
All grains	148.3	69.1	46.5
Rice and wheat	117.1	67.1	57.1
Wheat	31.1	15.5	50.0
Rice	85.9	51.6	60.0

Source: Yudelman, 1994

Between the 1960s and the 1990s real food grain prices fell by approximately 50 percent. This decline was, according to Barker and v. Koppen (1999) due principally but not entirely to the impact of the so-called green revolution in the developing countries. The subsidisation of food grain production by the developed economies also contributed to the decline. Determining the precise share of the gains in cereal grain production attributable to new varieties, fertilisers, and irrigation is an almost impossible task. However, there is little doubt, according to Barker and v. Koppen (1999), that without the advances in irrigation technologies and extraordinary investments in irrigation expansion by both the public and private sectors, the impact of the green revolution would have been greatly reduced. The benefits of lower food grain prices to the people in third world countries, especially to the poor are obvious. Sixty percent of the money spent on food by the people below the poverty line in Asia is apportioned for cereals, which provide as much as 70 percent of their total nutrients.

While irrigated area grew at 2 percent per annum during most of the past three decades, the period of major construction of new irrigation systems has come to an end. Future growth in new cropland irrigated is projected at less than 1 percent per annum. In fact, with the losses in irrigated land due to salinity, urbanisation, and other factors, the net irrigated area in the world may already be declining. With potential crop yields still well above those now being obtained by farmers, water is now more binding than the agronomic constraint to increased crop production.

The development and expansion of tube well irrigation contributed significantly to the increase in food production during the last decades. However, in the arid and semiarid regions, the point has now been reached where overexploitation of groundwater poses a major threat to the environment, health and food security. Barker and v. Koppen (1999) consider this a threat to the welfare of the poor far more serious than that posed by the widely criticised construction of large dams.

## Prerequisites for sustainable solutions

A large share of water to meet new demands must come by saving water from existing uses through comprehensive reform of water policy. Such reform will not be easy, because both long-standing practice and cultural and religious beliefs have treated water as a free good, and because entrenched interests benefit from existing arrangements.

The precise nature of water policy reform will vary from country to country, depending on underlying conditions such as level of economic development and institutional capability, relative water scarcity, and level of agricultural intensification. Additional research is required to design specific policies within any given country. According to Rosegrant (1995) key elements of comprehensive reform should include the following:

**Secure water rights.** Reform must provide secure water rights vested in individual water users or groups of water users. In some countries and regions, these rights should be tradable, which further increase the incentives for efficient water use. Such a reform can empower water users, provide investment incentives, improve water use efficiency, reduce incentives to degrade the environment, and increase flexibility in resource allocation.

**User management of irrigation systems.** In many developing countries, devolving irrigation infrastructure and management to water user associations will be beneficial. In the past, such steps often failed because they were not accompanied by secure access to water. Well-defined water rights provide the incentive for user groups to economise on water use, to bargain effectively with the water conveyance bureaucracy for timely and efficient service, and to undertake operations and management.

**Reformed price incentives.** Privatisation and deregulation of urban water services, together with reduced subsidies for urban water consumption, can also improve efficiency. When incremental water can be obtained at low cost owing to subsidies there is little incentive to improve either physical efficiency (such as through investment in pipes or metering) or economic efficiency. Secure water rights held by the urban companies and an active market have encouraged the construction and operation of improved treatment plants that sell water for agricultural or urban use. Removing subsidies on urban water use can have dramatic effects. Rosegrant (1995) assumes that the reforms described would free up substantial resources for both productive investment and targeted subsidies to the poor and groups who might be left out of the reform process.

**Appropriate technology.** Availability of appropriate technology will be essential as incentives are introduced for water conservation. Small-scale water harvesting techniques can have high payoffs in certain agro-climatic environments. As the value of water increases, sprinkler, computerised control systems, and drip irrigation using low-cost plastic pipes, all of which are common in developed countries, could have promising results for developing countries.

**Environmental protection.** Greater protection must be afforded to water and soil quality. The appropriate approach to environmental protection is likely to include both regulatory and market elements. Increased water prices or establishment of tradable water rights can cause farmers to take account of the costs their water use imposes

on other farmers, reducing the pressure to degrade resources. Rosegrant (1995) illustrates this in a simple example. A farmer at the head of a canal who overuses water, thereby waterlogging other farmers' land through excess return flows, seepage, and percolation. If he could trade the excess water instead, he would conserve resources. Although any society can design effective environmental protection policies, how much environmental protection will be provided will be a matter of political choice and commitment.

**International co-operation.** Water policy reform must transcend national boundaries. In many regions, long-term solutions will require international co-operation between countries sharing scarce water resources. Intergovernmental activities to settle conflicts over shared water bodies of water have had mixed success. Co-operation between countries sharing the same water basin will become increasingly important as water becomes scarcer. Reconciliation is cheaper than armed conflict. Rosegrant (1995) sees a key to defusing potential international conflicts over water in a national water policy reform to ensure the most efficient use of available water supplies. Countries must therefore begin the painful process of reforming national water policies and treating water as a scarce resource.

## A Vision of the Future

Through its own research coupled with that of the International Food Policy Research Institute (IFPRI) has allowed the International Water Management Institute (IWMI) to arrive at a vision of the world water situation over the next 25 years. This is best characterised by summarising some of the major findings of this research:

IFPRI projects that demand for cereals will increase by 48% by 2025. Virtually all of this increase will be in developing countries, and most of it will be for feed grains to produce animal products - meat, milk, eggs, etc. The demand for vegetables and fruit, nearly all of which must be irrigated, will increase even more rapidly.

Population will grow about 38%, from the present level of 6.0 billion to 7.8 billion people in 2025. Again nearly all of the increase will be in developing countries. Per capita food supplies are expected to increase in most developing countries enough to satisfy reasonable nutritional requirements - with the major exceptions being in sub-Saharan Africa.

In order to achieve these food production levels, the irrigated area of the world will have to increase by about 34%, from about 250 million hectares in 1995 to 350 million hectares in 2025. This is true even with the most efficient and productive use of existing irrigation water that can be reasonably expected.

IWMI projects that better utilisation of existing water resources in irrigated agriculture could generate additional water supplies to irrigation, increasing by 17% over present levels. The only alternative to increasing productivity per unit of land and water would be massive and environmentally destructive conversion of forests and grasslands in agroclimatically favourable areas of Latin America and sub-Saharan Africa to rain fed agriculture.

Even so, nearly one-third of the population of developing countries in 2025, some 2.7 billion people, will live in regions of severe or 'absolute' water scarcity. They will have to reduce the amount of water used in irrigation and transfer it to the domestic, industrial and environmental sectors. Many countries in the arid regions of the world will depend on increased imports to meet the food needs of their people. While there is sufficient production potential in exporting countries to provide this food, it is not at all clear how the importing countries - especially those in sub-Saharan Africa - will find the funds to pay for these food imports.

Groundwater reserves will be increasingly depleted in large areas of the world. In some instances this will threaten the food security of entire nations dependent on highly productive agriculture irrigated with pumps, such as India; it will certainly lead to major problems for food security and access to safe water for poor households in the affected regions.

The people most affected by growing water scarcity will continue to be the poor, especially rural poor, but also the urban poor; and among poor people, women and children will suffer most. If the world fails to invest in the research and development needed to find solutions, and in the application of these solutions, the health, livelihoods and incomes of millions of poor people will deteriorate.

Last, if irrigation and water resources generally are not managed much more effectively and efficiently, the additional water required by irrigation will double. It is now generally recognised that water is the major constraint on food production and one of the major constraints on health and environmental quality in a large number of developing countries. It is water, not land, that could provide the foundations of a Malthusian crises in these countries.

## **A vision of Egypt's water future ?**

Egypt has only one main source of water, the Nile River. The availability of the reliable water supply from the Aswan High Dam is governed by the existing water-sharing agreement, under which 55.5 billion cubic meters are allocated to Egypt. Most of Egypt's water uses are within the agricultural sector, with 84% for agriculture, 8% for industry, 5% for municipalities, and 3% for navigation (Abu Zeid, 1994). Meanwhile, yearly about 4 billion cubic meters of agricultural drainage water is officially reused for irrigation. The groundwater aquifer underlying the Nile Valley and the Delta is entirely recharged from deep percolation from the Nile. The per capita share of fresh water resources is now 950 cubic meters per person per year; it is expected to drop to 350 cubic meters per person by the year 2025. With other words the distribution of Egypt's share of the Nile's water to its population barely reaches the water poverty threshold and will fall well below this threshold in the years to come.

In a study to project the water supply and demand for 118 countries over the 1990 - 2025 period Seckler et al. (1999) came to the conclusion that Egypt is projected to be in a state of absolute water scarcity by 2025. Egypt belongs to the group of countries, within the 118, which do not have sufficient annual water resources to meet reasonable per capita water needs for their rapidly expanding populations. These countries will almost certainly have to reduce, according to Seckler et al. (1999) the amount of water used in irrigated agriculture and transfer it to the other sectors, importing more

food instead. By importing food Egypt is virtually importing water in huge amounts. If one considers that the amount of 1,000 tons of water is needed for evapotranspiration to produce 1 ton of grain Egypt is already importing virtually up to 10 billion cubic meters of water annually. This amount will increase as Egypt's population increases and more food is needed in the years to come. This is because there is no extra water to increase food production within Egypt in quantities necessary to meet the growing demand by the population increase.

Looking at the water balance of Egypt it becomes clear that it is an illusion to believe that the Egyptian agricultural area can be expanded to the planned extent. Because of the scarcity of water there are also limitations in increasing agricultural production, as the increase in plant production is correlated with the plants' consumptive use of water. Because of these limitations will have to open-up and develop alternative branches of the economy, instead of investing in the reclamation of marginal lands.

Of course Egypt still can hope, that rapid advances in technology, governance and the economy will help to solve the existing and upcoming problems of water scarcity and degradation. But they will not allow Egypt to assume that the water problems of the country will go away. The eminent historian Charles van Doran (1991) has said,, according to Serageldin (1999), that forecasting the future of knowledge is not just difficult, it is 'impossibly squared'.

But while we cannot see far into the future, on the water front we can see some distance ahead, and what we see gives more reasons for alarm than the comfort. The challenges are daunting. We must think boldly, and act now (Serageldin, 1999).

Egypt has to act now. The necessary action will involve not only water sector and environmental professions, but also policy and decision makers, all the Egyptian people, that is the whole of the Egyptian society.

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## **Irrigated Agriculture in Egypt - notes of an external observer**

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### **Introduction**

Agriculture is still an important economic activity of Egypt, and the sustainability of this sector is vital for the overall development of the country. Agriculture employs over 40% of the labour force and provides a noticeable source of the GDP with a share of 16%. Consequently, how to sustain the development of agriculture and thus the national economy is an important issue in Egypt. This issue is becoming ever more acute as the pressure on water, land and other natural resources increases. This paper intends to highlight some of the most important constraints irrigated agriculture is facing in Egypt.

### **Resource base and frame conditions**

#### **Soil resources**

Egypt occupies a total area of about one million square kilometres, or 238 million feddans (99.17 million hectares), of which only a small portion (about 3.5%) is agriculturally productive. The agricultural land base of Egypt totals about 7.8 million feddans (3.25 million hectares) covering three different production zones. The first is the old irrigated land with an area of 5.4 million feddans (2.25 million hectares) lying within the Nile Valley and Delta. It represents the most fertile soils in Egypt, which is alluvial, level, deep, dark brown and heavy to medium in texture. Its organic matter content ranges from 1.1 to 2.3 % with pH values between 7.3 and 8.3. According to USDA soil taxonomy, the order Vertisols dominates the major part with the existence of the orders Entisols and Aridosols.

The second production zone is the "newly" reclaimed land, which is viewed as an opportunity for increasing the cultivated area by about 1.9 million feddans. This includes the newly reclaimed land of sandy, calcareous, and saline origin. Soils are poor in organic matter and in macro and micro nutrients.

The third zone is the rainfed area (about half a million feddans) located along the Northwest Coast and in North Sinai. On a per capita basis, Egypt's area of cultivated land, at 0.13 feddan per person, is among the lowest in the world. Despite the ever increasing cultivated area through the governments' arid lands reclamation programs, land per capita has steadily declined over the years (Abdel Monem et al., 1998).

## **Water resources**

Agriculture in Egypt is almost entirely dependent on irrigation; the country has no effective rain except in a narrow band along the northern coastal areas. Egypt has only one main source of water, the Nile River. The availability of the reliable water supply from Aswan High Dam is governed by the existing water-sharing agreement, under which 55.5 billion cubic meters are allocated to Egypt. Most of Egypt's water uses are within the agricultural sector, with 84% for agriculture, 8% for industry, 5% for municipalities, and 3% for navigation (Abu Zeid, 1994). Meanwhile, yearly about 4 billion cubic metres of agricultural drainage water is officially reused for irrigation. The groundwater aquifer underlying the Nile Valley and the Delta is entirely recharged from deep percolation from the Nile. The per capita share of fresh water resources is now below 900 cubic meters per person; it is expected to drop to 350 cubic metres per person by the year 2025. With the expected increase in population, not only demand for irrigation water will continue to increase in the next decade and beyond. This implies that the agricultural sector will have to adjust to a smaller amount of available water than previously.

## **Cropping system**

Egypt's agricultural land is, on the average, highly productive and ideally suited to intensive agriculture. With good climatic conditions and a perennial source of irrigation water, agriculture is provided with excellent growing conditions, resulting in high crop yields. Crop productivity levels in Egypt are relatively high when compared to world standards. Productivity of wheat, corn and rice are 5.92, 6.21 and 8.26 tons per hectare (Gomaa, 1996). Due to intensive cropping, the total cropped area was estimated at about 12.1 million feddans, giving a cropping intensity of around 180% for the country as a whole. At present, it is estimated that cotton, wheat, rice, maize and clover (berseem) account for 80% of the cropped area. Wheat and berseem are the principal winter crops. In summer, cotton and rice are important cash crops while maize and sorghum are major subsistence crops. Livestock is an important and integrated part of the agricultural system, as 85% of all livestock is found on small farms.

## **Economic Policies**

Egyptian agriculture is currently in a transitional period. The two decades of the 1960s and 1970s were characterised by heavy government intervention in agriculture. Output prices were controlled, inputs were subsidised, quota deliveries at fixed prices of the major food commodities, like wheat, maize, and beans, were compulsory, and land rent was controlled. Cropping pattern was influenced by area allotments required for the major crops like cotton, sugar cane, rice and wheat. Farmers decisions during that period were heavily influenced by those policies. In the late 1980s, as part of an economic reform program, agricultural market liberalisation policies were initiated. Output markets were liberalised and quota deliveries were eliminated. In addition, subsidies on inputs were reduced and crop area allotments were eliminated for most crops. The new policies have provided farmers with new flexibility in the cropping patterns and resource allocation that will affect the agricultural sector. Increasing wheat production in recent years following a dramatic rise in prices and improved technology gives an example of the impact of new policies.

The period of rapid adjustment, during which government revenues from the agricultural sector fell sharply, also provided an opportunity to adjust other prices to more appropriate levels. To some extent this was done - subsidies for farm inputs were as mentioned above reduced. But charges for water services to agriculture and to other

users were not introduced. Water still is provided free in bulk to all users by the Ministry of Public Works and Water Resources. Intermediate services of treating water for domestic consumption are charged for by the agencies concerned (Perry, 1996).

## Threats to sustainability

Despite the fact that the use of high levels of inputs, developing improved varieties, using the agricultural land to its potential, and implementation of other cultural controls has resulted in historic increases in crop productivity, the sustainability of Egypt's agricultural system is endangered by a number of constraints. These constraints have been identified in part during inventory studies carried out by the Agricultural Research Centre of Egypt (ARC), the International Centre for Agricultural Research in the Dry Areas (ICARDA) within the EU financed Nile Valley and Red Sea Regional Program (Hamissa, M.R. et al., 1998). These constraints can be grouped into water management, agronomic, extension and institutional and policy constraints.

### Water management constraints

Water management in Egypt faces the following constraints:

- Inequity of water distribution between the heads and tail ends of distributary canals and *mesqas*.
- Irrigation farmers are increasingly apathetic towards the operation of the irrigation system and seek to exploit localised solutions to obtain more reliable water supplies.
- The major problems in unlined canals are generally seen in weeds, seepage, and unstable cross-sections. But if one analyses the maintenance problems of the public irrigation and drainage infrastructure in Egypt it becomes obvious that this is a very complex issue. Under 4. the results of such an analysis are summarised.
- Removal of weeds and general maintenance of private *mesqas* is traditionally the responsibility of the farmers. However, in view of the excessive weed growth in some cases and the blocking of canal cross-sections caused by sediment, garbage materials, and debris in others, especially those running through or besides villages, farmers in many cases are unable to cope with this situation.

### Agronomic constraints

Poor soil fertility, associated with salinity and alkalinity problems, represents a major limiting factor for the productivity of most field crops. About 500,000 feddans (210,084 hectares) of heavy soils, located in the northern part of the country, are highly saline, partly with poor internal drainage properties. The sodicity hazard of some of these soils is high and their permeability is low. Reclamation requires improvement of their physical and chemical properties through leaching, amendments, subsoiling, and deep plowing with good, appropriate drainage.

Other constraints are:

- Excessive freshwater loss to drains due to over-irrigation, poor land levelling etc.
- Poor plant stands, associated with hand seeding. The resulting low and uneven plant density cannot make efficient use of fertilisers.

- Poor management practices such as:
  - Poor seedbed preparation at planting.
  - Uneven seed depth and cover.
  - Late planting in some locations.
  - Fertiliser abuse, as a result of high application rates and low percentages of nutrient (nitrogen) utilisation.
  - Poor weed control in the field.
  - Disease damage in some field crops.
  - Insect damage, especially aphid, to food legumes, wheat, and barley.
  - Primitive methods of harvesting, threshing, transportation which might cause heavy yield losses.
  - Storage insects lead to grain loss and bad seed quality.

### **Extension constraints**

Although there are constraints in any research program, the main problem in Egypt is how to transfer the already available research results to the farmers. Extension programs in Egypt face a variety of constraints.

These constraints are mainly:

- Lack of communication between research and extension.
- Inadequacy in delivering research results quickly and effectively to extension specialists and dissemination to farmers.
- Isolation of extension agents from each other.
- Farmer suspicion towards government personal.
- Shortage of well-trained extension workers.
- Engagement of extension personnel in many other governmental activities.

### **Institutional and policy constraints**

The failure to deal effectively with the problems of farmers and their relationship to environmental degradation, to sustainability issues arises from numerous complex and interacting factors. Here institutional and policy constraints play an important role.

In Egypt such constraints to irrigated agriculture are:

- Top-down centralised state-controlled institutions and minor official role of traditional local institutions in areas such as conflict resolution and the regulation and maintenance of the irrigation system.
- Inflexibility of state-controlled irrigation systems management.
- Inability of national institutions to exercise authority effectively at the local level and the lack of empowerment of local institutions to co-ordinate activities at their level.
- Land losses and low land/population ratio: Due to urbanisation expansion, it is estimated that about 30,000 feddans are lost annually (El Belassy, 1992). The per capita share of land declined from 0.5 feddan in 1897 to 0.1 feddan in 1992 (Abu Zeid, 1994).
- Division of various research and production efforts on the same crop between various institutes and sections.
- Gap between research and extension.
- Nonavailability of inputs in quantity, quality and in time.
- Lack of dynamic administrative and management systems.

## Maintenance - the bottleneck of Egypt's irrigation and drainage system

### General remarks

Maintenance is defined simply by Ostrum (1993) as "any activity that slows the deterioration of a facility, whether caused by use or ageing." Carruthers and Morrison (1994) provide according to Svendsen (1994) a somewhat more operational specification of maintenance as

*.... a management response to the deterioration of the physical condition of irrigation and drainage systems that threatens to make it impossible to achieve operational targets.*

The above definition contains several notable features. The most important being that maintenance is described as a management response. This suggests that, for effective maintenance at least, the responsible institution must have objectives related to maintenance and make real-time decisions regarding maintenance in response to changing conditions. In short, it must be a managing agency and not an administrative one.

Four basic categories of maintenance can be identified in the O&M of irrigation and drainage systems:

(1) desilting, (2) weed control, (3) maintenance of structures, (4) maintenance of mechanical equipment such as pumps and engines. To this list can be added, according to Svendsen (1994), (5) maintenance of decision support facilities. The category comprises the measurement, communication, and decision support systems which allow the intelligent and responsive control of water in the irrigation and drainage system. Together the condition of these system facilities constrains or enables the ability of the system to deliver or drain water by affecting canal carrying capacity, water storage capacity, and regulatory capacity. A sixth category of maintenance usually carried out by irrigation and drainage agencies comprises of maintenance of appurtenant structures and facilities such as project buildings and access roads.

Maintenance of open canals and drains is not just the physical part of dewatering and desilting operations. It is a management undertaking requiring a high degree of flexibility in decision making on the spot, at the local level.

### Maintenance problems observed in Egypt

Weed problems are generally severe on the Egyptian canals and have been attributed to the closure of the High Aswan Dam which reduced the annual silt load of the Nile enhancing the penetration of light through the water and increasing the growth of submerged species like *Potamogeton pectinatus* and *Potamogeton nodosus*. It is according to Barbben and Bolton (1988) reported by maintenance engineers that weed growth was not a problem in the period before regulation of the Nile. Whether this also applies to the then relatively sparse open drainage system is not known.

The irrigation and open drainage system in Egypt consists mainly of unlined earth canals to distribute or collect water. Canal velocities are low. Drains often contain stagnant or very slow moving water. Together, with favourable climatic conditions, make ideal habitats for aquatic plants. The increase in fertiliser application most probably increased the nutrient content of the drainage water and encouraged even more the

growth of weeds. All types of aquatic weeds are common in the open drains that is submerged, ditch bank, emergent and floating weeds. It seems to depend on the site conditions whether one or the other type is dominant. Because of the weed infestation the roughness is sufficiently high to decrease the flow of the irrigation canals and open drain system.

The maintenance of the irrigation and drainage infrastructure in Egypt is, as in other countries, a very complex issue. Therefore no simple solutions can be found. The following reasons for poor maintenance are most commonly found in Egypt:

(1) technical problems

- inadequate physical operation of maintenance works
- oversized canal sections through over excavation
- missing service road network
- bridges and pipelines as obstacles
- difficult mechanical removal of biomass (especially submersed weeds)
- mechanical maintenance makes large amount of specialised equipment necessary

(2) management problems

- lack of strategic vision in relation to maintenance
- inadequate long range conceptual planning capability
- staff availability unsatisfactory
- training of staff insufficient
- contracts for annual instead for several years maintenance
- no preventive maintenance
- lack of comprehensive operational plans
- lack of accountability and incentives
- lack of liaison between irrigation or drainage authority and water users

(3) financial problems

- dependency attitude of farmers upon free services from the state
- no well developed direct cost recovery system
- system for assessment and collection of O+M costs missing
- inadequate budget
- underpayment of contractors
- bureaucratic financial procedures

(4) legal problems

- use of chemicals banned since Dec. 1991
- legal framework for drainage associations and engagement in maintenance is non-existent or not in operation

(5) sociocultural problems

- attitude of society in respect to preventive maintenance is underdeveloped
- lack of interest of farmers in participating or collaborating in maintenance work
- poverty and maintenance
- over fishing of grass carp
- maintenance lacks the prestige of construction among professional staff
- low social status of maintenance work

(6) ecological problems

- maintenance interferes with ecosystems of canals
- solid waste disposal at canal banks
- disposal of sewage into irrigation and drainage canals

(7) health problems

- increase of vector borne diseases through poor maintenance (Schistosomiasis)

The Fayoum Water Management Project (1996) in studying different weed control methods came to the conclusion that:

- mechanical weed control, using the mowing buckets is an efficient method, as it prevents any further expansion and deepening of the water channels resulting from the use of the traditional excavation buckets;
- mowing buckets can be installed on various equipment available in Egypt;
- mowing buckets are cost efficient and can operate with high performance, if carefully used by the operators and if the labourers carry out the necessary maintenance works systematically with the required efficiency.

Despite these facts deweeding of irrigation and drainage channels in Egypt is still done in most cases by using the traditional excavation buckets. The single most important issue constraining a shift from this traditional method of channel excavation to weed mowing are the contracts for annual maintenance. The problem concerns the design of contracts, the duration of contracts, the tendency to follow an established maintenance system, the imprecise specifications for contracted work items and the structure of the unit rates.

### **A new strategic thinking is required**

There is a broad consensus among irrigation and drainage professionals that present maintenance standards are a crucial impediment to the efficiency and sustainability of irrigation and drainage systems. In many ways the irrigation and drainage maintenance problem is not unique. It is perhaps but a visible example of a general infrastructure maintenance problem providing education, health, transport and other elements of the public sector in the developing world (Carruthers and Morrison, 1994).

The recurrent cost problem has been identified by Carruthers and Morrison et al. (1994) as a major constraint on even the best designed maintenance organisations. However, throwing more money at the maintenance problem is very unlikely to resolve it. It is much more than likely that without other changes any additional resources will be wasted. More precision in diagnosis and clear criteria by which improvements can be judged will be required. The norms for rehabilitation and maintenance of drainage systems being developed by the M&E Project of the Egyptian Public Authority for Drainage Projects (EPADP) leads in the right direction and should be consequently implemented.

One has to be aware that in the maintenance of irrigation canals and open drains no general solution exists. This is because site conditions, especially weed growth conditions differ across Egypt, requiring different maintenance measures. This is why site specific maintenance strategies have to be developed and a high flexibility of the organisation responsible for maintenance and in management of the irrigation and drainage system is required.

Much maintenance presents arduous tasks and the potential returns are often not perceived by those involved especially in irrigation and drainage system management. This failure to recognise the value of maintenance is true for governments, for irrigation and drainage agencies and farmers. All these groups must be encouraged to participate in all aspects of planning, construction and implementation. Participation, especially of farmers, seems to be missing in Egypt. Especially drainage is seen by the beneficiaries in Egypt to be solely a government undertaking. In order to reach a high degree of sustainability of the irrigation and drainage system practical maintenance issues have to be high on the agenda at each stage in development. Beneficiaries have to become aware of the value of well functioning drainage systems.

The increased effective participation of farmers in maintenance is seen as one solution to its neglect. There is a general understanding that beneficiaries of the drainage systems installed by EPADP have to finance and execute its upkeep in the future, most likely through "drainage associations". It is not clear whether this general call for greater participation of beneficiaries in all aspects of drainage management can be applied in Egypt at present or in the near future, especially since drainage does not seem at present to be very high on the agenda of the farmers all over Egypt. This is particularly valid for the sugarcane farmers in the Nile Valley. To encourage optimal participation, the valid incentives must be clearly evident to all the players. But what are the incentives for the farmers for example? What can EPADP do to deliver these incentives? What organisational structure is appropriate to deliver these incentives? Under which conditions is it beneficial for farmers to participate?

One has to be aware that there might also be another side of the picture. The expectation that the farmers in Egypt are to execute and to finance the work that needs to be done on the drainage and partly on the irrigation systems could turn out to be wishful thinking of those remote from the field level problems, a reaction to shortages of government revenue, or simply a switch of tactics from centralised planning approaches to devolved participative mechanisms in line with a widespread current political fashion. If this is the case a different strategy has to be developed to improve the maintenance situation of the irrigation and drainage systems in Egypt on a sustainable basis. At least it is necessary to change from the present more or less schematic maintenance operations to more situation-conforming management of the maintenance works. It seems to be necessary to develop a respective strategy or concept which increasingly involves the beneficiaries in operation and maintenance of the irrigation and drainage system.

The maintenance of watercourses and especially open drains is in Egypt as in other countries increasingly discussed from an ecological point of view. The Research Institute of Weed Control and Channel Maintenance of Egypt's Water Research Centre besides others are considering weed growth in channels to some degree desirable for ecological reasons. It was found also to be of some advantage for water quality improvement. Such changing attitudes have to be considered when developing a maintenance strategy.

## Conclusions

Egypt's highly productive irrigated agriculture is subject to unprecedented expansion in area and intensification, while competition with industrial and domestic sectors for fixed supply of Nile water continues to increase. Salinization, heavy use of inputs, and pollution all threaten the health of the soils. At the same time, developing newly reclaimed desert soils and rainfed areas to possess economically sustainable productive capacities is seen as a major challenge. To achieve a sustainable development of Egypt's irrigated agriculture it takes more than just solving the technical and agronomic problems. Among others the sustainable solution of legal, sociocultural, ecological, health and financial problems have to be considered. Furthermore, limited resources and threatened production sustainability call for an efficient resource-management strategy and farming-system approach for agricultural development and research in Egypt. Such an research approach is followed within the EU financed Nile Valley and Red Sea Regional Program by the Agricultural Research Centre of Egypt and the International Centre for Agricultural Research in the Dry Areas (ICARDA). The approach should be extended to all agricultural research in Egypt. Such approaches have to be holistic, taking into account the socio-economic requirements of all sectors of the economy, of Egypt's society.

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## Surge flow irrigation for corn in clay soils

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### Abstract

Field experiments were carried out during 1996 and 1997 summer seasons at Sakha Agricultural Research Station, Kafr El-Sheikh, Egypt. These experiments aim to evaluate the furrow surge irrigation system for corn under different land levelling practices as a method to improve the efficiency of surface irrigation and water saving. The experiment was arranged in split plot design with three replicates. The main plots are assigned to land levelling practices (dead and traditional levelling), while the subplot treatments were the continuous flow irrigation and four cycle ratios of surge flow irrigation.

Obtained data showed that all tested cycle ratios of surge flow irrigation gave lower water advance times, lower amounts of applied water, higher water application efficiency and higher water distribution efficiency than that continuous flow irrigation. Advance inflow times were reduced in the case of surge flow to 21% and 20% of the time required for continuous flow under dead and traditional levelling, respectively. Amounts of applied water were reduced using surge flow irrigation by 19.1% and 16.5% of continuous flow irrigation under dead and traditional land levelling respectively. The average values of water application efficiency (WAE) varied from 68.6 to 84.2% and from 53.8 to 73.4% for surge flow irrigation under dead and traditional land levelling respectively. The corresponding values for continuous flow irrigation were 63.1% and 51.4%. Water distribution efficiency (WDE) increased using surge flow irrigation. The average WDE values under continuous flow irrigation were 85.4% and 77.1% for dead and traditional land levelling respectively. Corresponding values for surge flow irrigation varied from 88.0 to 94.7% and from 79.6 to 90.2%.

The results revealed also that the values of water consumptive use of corn were higher for continuous flow irrigation than that for surge flow one. The water consumptive use reduced with increasing the off-time in surge flow irrigation. The average of grain yield of corn under surge flow irrigation varied from 3.09 to 3.48 ton/fed. The corresponding value under continuous flow irrigation was 3.0 ton/fed. The dead levelling achieved higher grain yield than that traditional levelling. The average values of water utilization efficiency for continuous flow irrigation were 0.90 and 0.78 Kg/m<sup>3</sup> under dead and traditional land levelling, respectively. The corresponding values for surge flow treatments varied from 1.04 to 1.46 and from 0.86 to 1.14 Kg/m<sup>3</sup>. For all the studied parameters the surge flow irrigation with cycle ratio of 0.5 (20 min. on and 20 min. off) gave the best results.

## Introduction

Irrigation was initially introduced in Egypt as surface irrigation, about more than 3000 B-C. Surface irrigation is practiced as flooding the soil surface by basin or border irrigation, or running the water in small ditches or furrows. Despite the fact that, sprinkler and trickle irrigation are used to maximize the crop yield for unit water, the surface flooding irrigation is still the most widely used. This is because of the high cost of trained labor and energy required to conduct the alternative systems.

Generally, surface irrigation efficiency is around 50%. Over years, minor changes have been made to increase the efficiency of surface irrigation. Land smoothing, cutback technology and tail water reuse along with proper scheduling are used to reduce water losses and improve irrigation efficiency. The latest improved surface irrigation method is through surge flow irrigation (James, 1988). Many researches have been carried out either theoretically and/or experimentally, to study the several aspects of surge irrigation and to determine the involved mechanisms. However, in Egypt little work has been done on the field of water management and yield of field crops under surge irrigation, e.g. Ghalleb (1987), Zaghloul (1988) and Osman (1991).

The main objectives of the present study are:

1. To evaluate the furrow surge irrigation system of corn under different land levelling practices in heavy clay soils of Kafr El-Sheikh Governorate.
2. To improve efficiency of the surface irrigation and water saving.
3. To define the best surge flow furrow irrigation practices for corn crop owing to optimize the water utilization efficiency.

## Material and Methods

Field experiments were carried out at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, during the two successive summer seasons of 1996 and 1997. The station is situated at 31°N-07 latitude, 30°E-75 longitude. It has elevation of about 6 meters above sea level. It represents conditions and circumstances of middle northern part of the Nile Delta. The experimental site located near to the main open drain and was served by tile drainage established since 1989. The tile drainage system consists of subsurface, 10 cm inner diameter, PVC pipes spaced 20 m apart and buried at 1.65 m depth.

Soil samples from the experimental field were collected for different soil depths, 15 cm each down to 60 cm, and analyzed for both some chemical properties and soil texture. The soil saturation extract was obtained. Total soluble salts (EC), acidity number (pH) and soluble cations and anions were determined by the methods described by Jackson (1962). The mean values are given in Table (1). In general the soil is non saline.

Table 1: Some chemical and physical analysis of experimental site.

Soil Depth	Particle size distribution			Text- Ure	Bulk density Mg/m <sup>3</sup>	FC w%	PWP w%	Avail- Able Water W%	EC dS/m	Cation c mole/kg soil				Anion c mole/kg soil			pH
	Sand	Silt	Clay							Na <sup>+</sup>	K <sup>+</sup>	Ca <sup>++</sup>	Mg <sup>++</sup>	HCO <sub>3</sub> <sup>=</sup>	Cl <sup>-</sup>	SO <sub>4</sub> <sup>=</sup>	
0-15	15.18	18.85	65.97	Clay	1.09	47.2	25.38	21.82	1.50	0.76	0.02	0.30	0.10	0.55	0.21	0.46	8.15
15-30	19.90	13.80	66.30	Clay	1.15	40.5	21.85	18.85	1.57	0.79	0.02	0.31	0.10	0.57	0.22	0.48	8.00
30-45	16.59	16.97	66.94	Clay	1.24	39.0	21.19	17.81	1.65	0.89	0.02	0.34	0.10	0.65	0.23	0.50	8.00
45-60	12.65	15.24	67.12	Clay	1.26	38.5	20.81	17.69	2.78	1.25	0.03	0.84	0.27	0.45	0.23	1.71	7.90

The particle size distribution was determined according to the international pipette method, Black (1965). The obtained results (Table, 1) indicate that the soil is clayey in texture and the soil profile is uniform without distinct change in texture. Corn (*Zea mays* L.) as summer crop was sown in an agricultural rotation after wheat as winter crop. This rotation was repeated for two years. Sowing dates for corn were June 29, 1996 and June 30, 1997 for the first and second year, respectively. All cultural practices were the same as recommended for the area except the levelling and the irrigation treatments under study. The experiment was arranged in split plot design with three replicates. Each plot was  $3.5 \times 80 \text{ m} = 280 \text{ m}^2 = 1/15$  feddan). Eight stations ( $S_1$  to  $S_8$ ) were arranged every 10 m along the furrow to measure the flow advance pattern. The treatments were as follows:

Main treatment (land levelling):

A. Dead levelling (0.0%) B. Traditional method of land levelling.

Sub treatments: five irrigation treatments were applied after sowing:

- 1: Represent a continuous flow irrigation (control),
- 2: Surge irrigation with cycle ratio of 0.8 (20 min on and 5 min off),
- 3: Surge irrigation with cycle ratio of 0.67 (20 min on and 10 min off),
- 4: Surge irrigation with cycle ratio of 0.57 (20 min on and 15 min off), and
- 5: Surge irrigation with cycle ratio of 0.5 (20 min on and 20 min off).

The cycle ratios were chosen according to the possible applicability. The irrigation intervals were 15 days. The amount of water in each application was added whatever number of surges needed until reaching 95% of the run length (75 m). The irrigation water was conveyed to the experimental plots through an open channel using a centrifugal pump with a water meter to measure the total volume of applied water. The inflow rate was about 5.4 L/sec.

Soil samples were taken from three selected stations along the furrow of two replicates, before and 2 days after each irrigation and immediately before harvesting from the successive soil layers 0-15, 15-30, 30-45, 45-60 cm depth. Their moisture content on the dry weight basis were determined. The advance time of the water flowing in furrow of each treatment was recorded when the water front was reached each station along the furrow. The on-off cycle time was controlled by means of stop watch. The number of surges needed until the water reached 95% of the furrow length were recorded and the irrigation time was determined.

The applied irrigation water to each experimental plot was measured using spile tubes. The effective head of water above the cross section center of irrigation spile was measured several times during irrigation and the averaged value was 6 cm. The water in the canal was controlled to maintain a constant head by means of fixed sliding type gates.

The amount of water delivered through a spile of 10 cm inner diameter was calculated by the equation:

$$q = CA \sqrt{2gh}. \quad \text{or } q = 0.0226 D^2 h^{1/2} \quad \text{Israelson and Hansen (1962)}$$

Where:  $q$  = Discharge of irrigation water (L/sec),

$C$  = Coefficient of discharge = 0.64 according to Osman 1991,

$g$  = Gravity acceleration,  $980 \text{ cm/S}^2$ ,  $A$  = Inner cross section area of irrigation spile,

$h$  = Average effective head, cm, and  $D$  = Inside diameter of the spile tube, cm.

The volume of water for each strip ( $3.5 \times 80 = 280 \text{ m}^2$ ) delivered to five furrows of 80 m length and 0.7 m apart was calculated by substituting Q in the following equation:

$$Q = q \times T \times n$$

Where: Q = Water volume  $\text{m}^3/\text{strip}$ , q = Discharge  $\text{m}^3/\text{min}$ ,

T = Total time of irrigation (min) and n = Number of spile tube per each strip.

The total on-time under continuous and surge flow irrigation was calculated using a stop watch. To evaluate the flow advance rate for different treatments the approach of

Christiansen *et al.*, 1966 was used as:  $L = a t^b$

In which: L = Length of advance, t = Time of advance and a, b = Empirical constants.

Crop water consumptive use (cm) was determined as follows:

$$C_u = \sum_{i=1}^{i=4} \frac{P_{w2} - P_{w1}}{100} \times D_{bi} \times D_i$$

Where:  $C_u$  = Consumptive use, cm. i = Number of soil layers,

$P_{w2}$  and  $P_{w1}$  = Percentage of soil moisture content 48 hours after irrigation and before irrigation for the specified layer,  $D_i$  = Depth of soil layer = 15 cm, and

$D_{bi}$  = Bulk density of the specified soil layer  $\text{gm}/\text{cm}^3$ .

Dates of harvesting of corn were Oct. 20, 1996 and Oct. 25, 1997 for the first and second season, respectively. Five plants from the central ridges at each station, were randomly chosen to determine the grain yield (ton/fed.). The water utilization efficiency as a measure to clarify variations in yield due to irrigation water was calculated according to Michael (1978) as follows:

$$WU_tE = Y/Wa$$

In which:  $WU_tE$  = Water utilization efficiency ( $\text{kg}/\text{m}^3$ ),

Y = Total yield produced  $\text{kg}/\text{fed.}$ , and  $Wa$  = Total applied water  $\text{m}^3/\text{fed.}$

The collected data for grain yield were subjected to the statistical analysis according to Snedecor and Cochran (1967) and the mean values were compared by L.S.D. test and Duncan multiple range test (DMRT) according to Duncan, 1955.

## Results and Discussion

### 1. Advance rate:

The data listed in Tables (2 and 3) revealed that the surge flow treatments had higher water advance rates, either under dead or traditional levelling, compared with the continuous flow irrigation treatments. The equations relating L and T, mean values, were:  $L = 0.79 T^{1.004}$ ,  $L = 0.741 T^{1.039}$ ,  $L = 0.680 T^{1.082}$ ,  $L = 0.635 T^{1.136}$  and  $L = 0.619 T^{1.176}$  under dead levelling, respectively for treatments  $A_1$ ,  $A_2$ ,  $A_3$ ,  $A_4$  and  $A_5$ . The corresponding equations for the traditional levelling were  $L = 0.729 T^{0.975}$ ,  $L = 0.654 T^{1.027}$ ,  $L = 0.583 T^{1.069}$ ,  $L = 0.503 T^{1.116}$  and  $L = 0.527 T^{1.121}$ , respectively for the treatments  $B_1$ ,  $B_2$ ,  $B_3$ ,  $B_4$  and  $B_5$ . Also the constant (b) of the equation increased with decreasing of the cycle ratio and had relatively higher values under dead levelling than under the traditional one. This indicates that water advance rate is faster with decreasing the cycle ratio (or with increasing off-time) and under dead levelling than under the traditional levelling treatments.

The overall mean of time required for water advance to reach the end of the furrow varied from 86.3 to 66.7, with an average of 76.3 min and from 106 to 85.7, with an average of 95.2 min for surge flow treatments, under dead and traditional levelling

respectively. The corresponding values for the continuous flow varied from 97.3 to 115.5 min under dead and traditional levelling, respectively. This means that the irrigation is completed faster when surge flow irrigation technique is used. Surge flow saved 21% of the time required for continuous flow to complete the irrigation, under dead levelling. The corresponding value under traditional levelling was 20%. This saving of irrigation time under surge flow was mainly because of the faster water advance rate under surge flow than under the continuous flow. The best treatment was that of 0.5 cycle ratio (20 min on and 20 min off). These results indicated that surge flow had faster advance rate with the longer off-time due to the effect of wetting and drying cycles on soil infiltration characteristics, Goldhamer *et al.* (1987). Increasing the off-time in surge flow reduces infiltration rate and results in greater advance on wetted area, Guirguis (1988). The trend of these results is in accordance with those obtained by Moustafa (1992) and Osman *et al.* (1996).

## 2. Applied irrigation water:

The number of irrigations during the whole season was seven irrigations including the sowing irrigation. The amount of the applied water to each treatments are given in Tables (4 and 5). The total amount of applied water varied according to the differences in irrigation treatments. All tested cycle ratios of surge treatments used less amount of water than that continuous one. Average volumes of applied water for continuous flow treatment ( $A_1$ ) were 3402 and 3813  $m^3/fed$  for dead and traditional levelling, respectively. The average amounts of added water by surge flow treatments  $A_2$ ,  $A_3$ ,  $A_4$  and  $A_5$  were, 3074, 2832, 2665 and 2447  $m^3/fed$ , under dead levelling, respectively. The corresponding values under the traditional levelling were 3516, 3261, 3053 and 2883  $m^3/fed$  for treatments  $B_2$ ,  $B_3$ ,  $B_4$  and  $B_5$ , respectively. The surge flow irrigation reduced the applied water by 9.7, 16.8, 21.8 and 28.2% for the treatments  $A_2$ ,  $A_3$ ,  $A_4$  and  $A_5$ , respectively under dead levelling. The corresponding reductions of the added water by surge flow under the traditional levelling were 7.8, 14.3, 20.2 and 23.9% for treatments  $B_2$ ,  $B_3$ ,  $B_4$  and  $B_5$ , respectively. In other words, surge flow irrigation saves water, on average for all treatments, by about 19.1% and 16.5% of the continuous flow irrigation, under dead and traditional levelling, respectively. This means that dead levelling emphasized the saving of the applied irrigation water to corn crop. Increasing the off-time in surge flow results in greater water saving. The best treatment in saving water was that of 20 min on and 20 min off (0.5 cycle ratio). It saved water of 28.2% (959.4  $m^3/fed$ ) and 23.9% (911.4  $m^3/fed$ ) of the applied water using continuous flow irrigation under dead and traditional levelling, respectively. The trend of these results is in accordance with those obtained by Ghalleb (1987) and Osman (1991). On the other hand, data revealed that the soil under traditional method of land levelling received higher amount of irrigation water than that under dead levelling. These results are in a harmony with those obtained by El-Mowelhi *et al.* (1995).

## 3. Water application efficiency (WAE)

The calculated WAE values for the different irrigation treatments are illustrated in Figure (1). The surge flow had higher values of WAE compared with the continuous flow irrigation. The overall average WAE values for continuous irrigation were 63.1% and 51.4%, under dead and traditional levelling, respectively. The corresponding values for surge flow irrigation treatments varied from 68.6% to 84.2% with an average of 74.5%, and from 53.8% to 73.4%, with an average of 63.9% under dead and traditional levelling, respectively. These results indicate that WAE under surge flow irrigation exceed the continuous flow irrigation with about 11.4% and 12.5% under dead and traditional levelling, respectively.









The high efficiency of surge flow can be attributed to the surface seal that causing by the intermitted wetting and the surface hydraulic roughness of the wet advance, Guirguis (1988). It was found that WAE increase with the decrease of the cycle ratio or the increase of off-time. The best treatment was that of 0.5 cycle ratio (20 min on and 20 min off). It had the highest value of 84% and 73% as average of the two seasons, under dead and traditional levelling, respectively. These results are in close agreement with those of Osman (1991) who found that the WAE values were 60.9, 73.7, 74.4 and 77.7% for continuous flow and for surge flow of 5/5, 5/10 and 5/15 on/off min, respectively at Sakha (Kafr El-Sheikh).

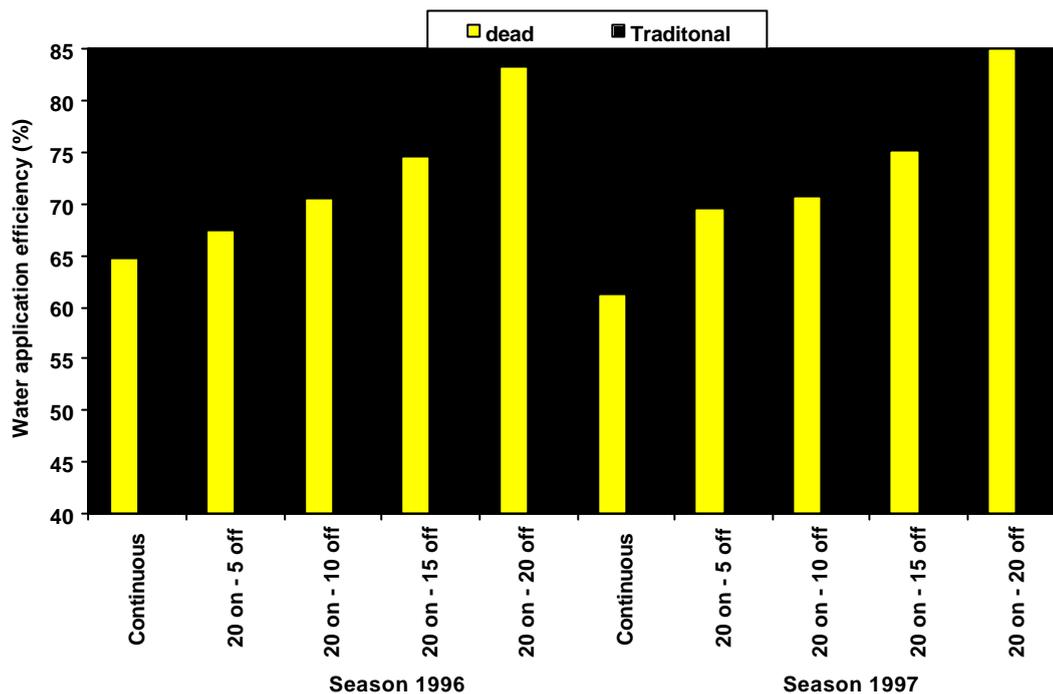


Figure 1: Values of water application efficiency (WAE) under dead and traditional levelling for furrow irrigation of corn during 1<sup>st</sup> and 2<sup>nd</sup> seasons.

#### 4. Water distribution efficiency (WDE):

As shown in Table (6) surge flow technique recorded higher values of WDE compared with continuous flow irrigation either under dead or traditional levelling. The overall average of WDE values, for the two growing seasons, under the continuous irrigation were 85.4% and 77.1% for dead and traditional levelling, respectively. The corresponding values for the surge flow irrigation treatments varied from 88.0 to 94.7% with an average of 91.4% , and from 79.6 to 90.2% with an average of 84.9% for dead and traditional levelling, respectively. It was found that WDE values increased whenever the cycle ratio decreased or the off-time increase. The best treatment was that of 0.5 cycle ratio (20 min on and 20 min off). It had the highest values of 94.7% and 90.2% for dead and traditional levelling, respectively. The trend of these data is in agreement with those obtained by Moustafa (1992) and Evans *et al.* (1995) who mentioned that the use of surge flow was superior to continuous flow furrow irrigation for maintaining acceptable application uniformities. On the other hand, the difference between WDE values of surge flow and these of continuous flow irrigation was rela-

tively low. It varied between 6 and 7.7%. This may be due to the nature of the clayey soils that crack severely, Pitts and Ferguson (1985).

**Table (6):** Values of water distribution efficiency (WDE) under different irrigation treatments for the furrow irrigation of corn.

Land Levelling	Treat.	Cycle ratio		Season 1996				Season 1997				Average of two seasons		
				Date of determination				Date of determination						
				On	Off	19/8	15/9	10/10	Average	13/8	7/9		28/9	Average
Dead Levelling	A <sub>1</sub>	Cont.	0	80.1	85.7	87.4	84.4	83.3	87.2	88.4	86.3	85.4	85.4	
	A <sub>2</sub>	20	5	83.4	86.5	92.6	87.5	85.5	89.3	91.7	88.5	88.0		
	A <sub>3</sub>	20	10	90.0	89.2	93.8	91.0	90.6	94.0	95.0	93.2	92.1		91.4
	A <sub>4</sub>	20	15	91.3	91.5	95.0	92.6	93.3	95.2	95.3	94.6	93.6		
	A <sub>5</sub>	20	20	93.0	94.5	96.3	94.6	94.4	95.3	96.2	95.3	94.7		
Traditional levelling	B <sub>1</sub>	Cont.	0	73.5	76.0	77.0	75.5	75.3	80.2	80.3	78.6	77.1	77.1	
	B <sub>2</sub>	20	5	78.4	79.3	80.5	79.4	78.6	79.8	81.0	79.8	79.6		
	B <sub>3</sub>	20	10	80.0	83.2	87.0	83.4	83.3	84.3	86.2	84.6	84.0		85
	B <sub>4</sub>	20	15	83.4	87.2	88.3	86.3	85.6	86.0	87.0	86.2	86.3		
	B <sub>5</sub>	20	20	89.7	90.3	90.4	89.9	89.0	90.4	91.0	90.4	90.2		

### 5. Water consumptive use (WCU):

As shown in Table (7) the values of WCU, average of the two seasons, varied from 41.6 to 47.9 cm and from 45.4 to 51.5 cm under the surge flow irrigation treatments for dead and traditional levelling, respectively. The corresponding values for the continuous irrigation treatment were 50.1 and 53.5 cm for dead and traditional levelling, respectively. The tendency of these results are in agreement with those obtained by Musick *et al.* (1987) who showed that surge flow irrigation reduced seasonal water use during 7 irrigations by 6%. Ghalleb (1987) found that the consumptive use for the continuous flow irrigation was higher (3.36 mm/day) than those for the surge flow irrigation, 3.18 and 3.0 mm/day respectively with cycle ratios of 1/2 and 1/4. Also, the surge flow treatments A<sub>5</sub> and B<sub>5</sub> recorded the lowest values of WCU (41.6 and 45.6 cm) under the dead and traditional levelling, respectively. The continuous irrigation treatments A<sub>1</sub> and B<sub>1</sub> had the highest values of 50.1 and 53.5 cm, respectively.

## 6. Grain yield:

Data tabulated in Table (8) showed that the highest grain yield was obtained under the surge flow treatment of 0.5 cycle ratio (20 min and 20 min off). It had an overall average of 3.48 and 3.40 ton/fed for the first and second seasons, respectively. On the other side, the lowest grain yields of 3.05 and 2.98 ton/fed were obtained under the continuous irrigation, for 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. This means that the increase in corn grain yield under the best treatment (0.5 cycle ratio) was 14.1% above the yield of the continuous irrigation.

**Table (7):** Water consumptive use (cm) of corn (season 1996 and 1997) for different treatments.

Land levelling	Treat.	Cycle		Season 1996		Season 1997		Average of two seasons	
		On	Off	Cm	m <sup>3</sup> /fed	cm	m <sup>3</sup> /fed	cm	m <sup>3</sup> /fed
Dead levelling	A <sub>1</sub>	Cont.	0	51.80	2175.6	49.3	2070.6	50.1	2104.2
	A <sub>2</sub>	20	5	48.30	2028.6	47.6	1999.2	47.9	2011.8
	A <sub>3</sub>	20	10	46.56	1955.5	45.3	1902.6	45.9	1927.8
	A <sub>4</sub>	20	15	44.47	1867.7	43.2	1814.4	43.8	1839.6
	A <sub>5</sub>	20	20	42.62	1790.0	40.6	1705.2	41.6	1747.2
Traditional levelling	B <sub>1</sub>	Cont.	0	54.60	2293.2	52.4	2200.8	53.5	2251.2
	B <sub>2</sub>	20	5	52.60	2209.2	50.4	2116.8	51.5	2163.0
	B <sub>3</sub>	20	10	48.20	2024.4	47.3	1986.6	47.8	2007.6
	B <sub>4</sub>	20	15	46.40	1948.8	45.4	1906.8	45.9	1927.8
	B <sub>5</sub>	20	20	45.60	1915.2	45.2	1898.4	45.4	1906.8

**Table (8):** Grain yield (ton/fed) of corn in the two growing seasons 1996 and 1997 as affected by irrigation treatments and land levelling practices.

Cycle ratio		Season 1996			Season 1997		
On	Off	Dead Levelling	Traditional levelling	Mean	Dead Levelling	Traditional levelling	Mean
Cont.	0	3.110 CD	3.00 D	3.055 D	3.000 EF	2.960 F	2.980 D
20	5	3.260 BCD	3.040 CD	3.150 CD	3.150 CD	3.030 DEF	3.090 C
20	10	3.340 ABC	3.170 CD	3.25 BC	3.220 BC	3.110 CDE	3.165 C
20	15	3.480 AB	3.270 BCD	3.375 B	3.430 A	3.150 CD	3.290 B
20	20	3.600 A	3.360 ABC	3.480 A	3.530 A	3.270 B	3.400 A
Mean		3.358	3.218		3.266	3.104	
L.S.D. at 5% = 0.323				L.S.D. at 5% = 0.1136			

Generally, surge flow irrigation had higher grain yield values than that the continuous one, either under dead or traditional levelling. The overall average of grain yield under surge flow treatments varied from 3.15 to 3.48 ton/fed and from 3.09 to 3.4 ton/fed for 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively. The corresponding values under the continuous treatment varied between 3.05 and 2.98 ton/fed for 1<sup>st</sup> and 2<sup>nd</sup> season, respectively. The dead levelling treatment achieved higher grain yield values than that the traditional levelling treatment. It had an overall average values of 3.35 and 3.26

ton/fed compared with 3.2 and 3.1 ton/fed for 1<sup>st</sup> and 2<sup>nd</sup> season, respectively. The statistical analysis showed significant differences between treatment of 20 min on/20 min off and the other treatments. While there were no significant differences between the treatments 20 on/5 off, and 20 on/10 off for the two growing seasons. The high production of corn under surge irrigation compared with continuous one may be attributed to the improvement of soil aeration conditions, more uniformity water distribution along the furrow and maintenance of nutrients. These results are in agreement with Ghalleb (1987) and Osman (1991) who found that the grain yields of corn under surge irrigation were higher than under the continuous one.

### 7. Water utilization efficiency (WU<sub>t</sub>E):

Values of WU<sub>t</sub>E for the different irrigation treatments under dead and traditional levelling are presented in Table (9). The surge flow treatments had higher values of WU<sub>t</sub>E than those of continuous flow ones. Also, WU<sub>t</sub>E values were higher under dead levelling than that under the traditional levelling. The overall average of WU<sub>t</sub>E values (average of two seasons) for continuous flow irrigation were 0.9 and 0.78 kg/m<sup>3</sup> under dead and traditional levelling, respectively. The corresponding values for surge flow treatments varied from 1.04 to 1.46, with an average of 1.25 kg/m<sup>3</sup> and from 0.86 to 1.14, with an average of 1.00 kg/m<sup>3</sup> under dead and traditional levelling, respectively. The best treatment was that of 0.5 cycle ratio, it had the highest WU<sub>t</sub>E value of 1.46 and 1.14 kg/m<sup>3</sup>, respectively for dead and traditional levelling. The explanation of these results, as mentioned before is that surge flow irrigation especially with dead levelling leads to higher water distribution uniformity, less water losses by deep percolation and less amount of applied water during the irrigation.

**Table (9):** Water utilization efficiency of corn (in kg/m<sup>3</sup>) under different irrigation treatments.

Treatment			Season 1996			Season 1997			Average	
Land levelling		Cycle ratio		Yield kg/fed	Wa m <sup>3</sup> /fed	WU <sub>t</sub> E Kg/m <sup>3</sup>	Yield kg/fed	Wa m <sup>3</sup> /fed	WU <sub>t</sub> E kg/m <sup>3</sup>	Average of two Seasons
		On	Off							
Dead levelling	A <sub>1</sub>	Cont.	0	3110.0	3435	0.91	3000.0	3368	0.89	0.90
	A <sub>2</sub>	20	5	3260.0	3137	1.03	3150.0	3011	1.04	1.04
	A <sub>3</sub>	20	10	3340.0	2952	1.13	3220.0	2713	1.18	1.15
	A <sub>4</sub>	20	15	3480.0	2780	1.25	3430.0	2423	1.41	1.33
	A <sub>5</sub>	20	20	3600.0	2583	1.39	3530.0	2310	1.52	1.46
Traditional levelling	B <sub>1</sub>	Cont.	0	3000.0	4082	0.73	2960.0	3544	0.83	0.78
	B <sub>2</sub>	20	5	3040.0	3780	0.80	3030.0	3259	0.92	0.86
	B <sub>3</sub>	20	10	3170.0	3465	0.91	3110.0	3057	1.01	0.96
	B <sub>4</sub>	20	15	3270.0	3288	0.99	3150.0	2818	1.11	1.05
	B <sub>5</sub>	20	20	3360.0	3133	1.07	3270.0	2675	1.22	1.14

Wa = total amount of the applied water during the season.

The above mentioned results are similar to those obtained by Osman (1991) who found that surge irrigation leads to increase water use efficiency by 0.69 kg/m<sup>3</sup> at Sakha farm and by 0.9 kg/m<sup>3</sup> at Abis farm than that water use efficiency for continuous irrigation. Ghalleb (1987) compared continuous flow irrigation with three different surge irrigation treatments of cycle ratio of 1/2, 1/3 and 1/4. He showed that WU<sub>t</sub>E was 0.58 kg/m<sup>3</sup> for continuous flow and varied between 0.79 to 1.0 kg/m<sup>3</sup> for surge flow irrigation.

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## Irrigation information in the Internet

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### Introduction

In less than a decade the Internet has become a real alternative to the well established means of information exchange. Electronic means of accessing information are rapidly gaining importance, thus increasing the speed of international and inter-continental information exchange. The use of the Internet has many advantages, since it grants online access from the own desktop to information distributed from anywhere else, without the hassle of visiting libraries, ordering and waiting for the ordered information or other restrictions.

The enormous advantages are clearly shown by the fact that the Internet is growing exponentially, both in the size of web sites, web pages and in the number of users. As shown in a study recently performed in the U.S. [17], in mid-1999 more than 100 million adult Americans used the Internet, which represents more than one-half of U.S. adults. Moreover, the Internet has become an important factor in their daily lives, which is clearly evidenced by the following statistics about their online-habits: daily use of the Internet has risen to 60 percent for home users and 69 percent for work users, clearly indicating the advantages linked with this medium. The average user sends 6.4 emails per day, and 77 percent of all users send emails with files or attachments weekly - an example of the even more sophisticated use of this tool. Also, more and more users are actively taking part in the process of information dissemination, with 22 percent of all users having created or updated a web page within the last three months.

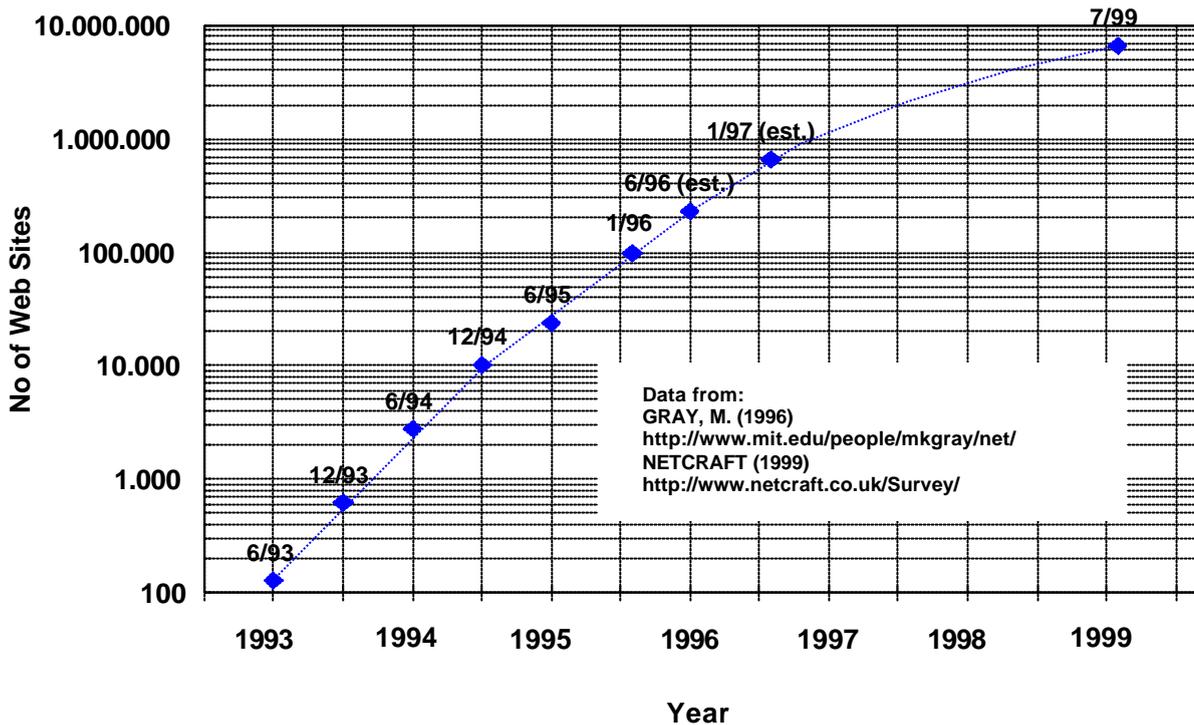
An analogous development can be found in the amount of information offered in the Internet. The so-called network of the networks is growing exponentially, enclosing already more than 10 million web sites (Figure 1) with the publicly indexable web containing an estimated 800 million pages as of February 1999 (1997: 320 million pages), encompassing about 15 terabytes of information or about 6 terabytes of text after removing structural elements, comments, and extra whitespace [7]. This growth is even expected to continue in the future, with an estimated number of 8 billion web sites in 2002.

The immense growth of both the number of Internet users and web sites indicates clearly the advantages of this medium, which almost each new user or web site indicating the expectation of potential benefit for the individual or the company they are working for. Each new user and each new web site can therefore also be considered as a vote for these possibilities and the further use of this new medium.

### The Internet - a short definition

According to a definition [4] unanimously agreed by the US Federal Networking Council, the term "Internet" refers to the global information system that

- is logically linked together by a globally unique address space, based on the Internet Protocol (IP),



**Figure 1:** The world wide growth of web sites form June 1993 till August 1999. Graph derived form data published by GRAY (1996) and NETCRAFT (1999).

- is able to support communications using a specific transmission protocol (TCP/IP) and
- provides, uses or makes accessible, (...) high level services layered on the communications and related infrastructure described herein.

It is important to notice that each computer that is part of the Internet has an unique IP-address, which is an indispensable condition for utilising these services or serving requests from other machines. Furthermore information transmission is standardised by the TCP/IP protocol in a platform-independent manner, so that different computers with differing operating systems all can share the resources of the Internet.

## Internet resources - Where to find information about irrigation?

### World Wide Web (WWW)

Originally initiated by Tim Berners-Lee while working on a networked information project at CERN, the World Wide Web is nowadays surely one of the most important, if not the single most important high level service of the Internet. The WWW is specifically designed for the exchange of documents available to the Internet community. These documents are formatted in a language called HTML (HyperText Markup Language) that supports links to other documents, as well as graphics, audio, and video files. This means one can jump from one document to another simply by clicking on hot spots, also called *links*. There are several applications called web browsers that make it easy to access the World Wide Web; two of the most popular being Netscape Navigator and Microsoft's Internet Explorer.

### Search engines and their deficiencies

With an estimated size of 800 million web pages, information retrieval can sometimes be quite difficult. Therefore, the proper use of search engines, which enable users to search for documents on the World Wide Web, plays a pivotal role. The database for the search engine can be either created by humans or by automated software tools, called spiders. An example of the human approach is Yahoo!, while Altavista or WebCrawler rely on an automatically created database. Beside these search engines, which were the very first at the time of their launch, numerous other engines have been installed since. A comprehensive list of search engines can be found at <http://www.amdahl.com/internet/meta-index.html>.

Unfortunately, the use of search engines can be quite tricky since finding the right information is not always easy. It can even be a very tough task - especially finding the engine that produces the output needed. Allegedly, the engines Google, DirectHit, and Northern Light are making use of some of the more innovative and best techniques used by search engines today, but even this does not guarantee good results. Furthermore, the use of search engines is generally subjected to some major restrictions: A recent study about accessibility and distribution of information on the WWW indicated clearly that search engine coverage relative to the estimated size of the publicly indexable web has decreased substantially in the last two years, with no single engine indexing more than about 16 % of the estimated size of the publicly indexable and accessible web. To overcome this problem, the use of meta search engines, which submit a single inquiry to several different engines at the same time and then list the results grouped together, is encouraged. Table 1 lists some of these meta engines.

It should be remembered when using search engines that their databases might be out of date resulting in outdated search results. As showed in [7], indexing of new or modified WWW pages by just one of the major search engines can take months.

Despite being indispensable tools, search engines still remain tools with adherent deficiencies. A search for the mere expression "irrigation" produces more than 310.000 matches using "NorthernLight" and almost 11.000 matches using "Google". In order to prevent one from becoming entangled and frustrated due to this flood of information, the next chapter will give some hints on finding the most valuable sites within the area of irrigation.

### World Wide Web Pages related to irrigation issues

A list of valuable WWW pages in the field of irrigation is shown in Table 2. Far from being complete, this list can serve as a starting point for retrieving professional and scientific information about irrigation on the Internet. Some of these sites are described in more detail in [8] and [11] (both sources can be accessed online). Especially valuable are search engines within a site, since the contents of their database are restricted to the visited web site. These tools can enormously facilitate the search for specific information since unlike the general search engines described above, they will narrow the search to irrigation specific contents.

**Table 1: Meta-search engines for searching the WWW**

Name	URL	Name (cont.)	URL
All4One	<a href="http://www.all4one.com/">http://www.all4one.com/</a>	Highway 61	<a href="http://www.highway61.com/">http://www.highway61.com/</a>
Ask Jeeves	<a href="http://www.askjeeves.com/">http://www.askjeeves.com/</a>	Metafetcher	<a href="http://www.metafetcher.com/">http://www.metafetcher.com/</a>
Copernic	<a href="http://www.copernic.com/">http://www.copernic.com/</a>	Metacrawler	<a href="http://www.metacrawler.com/">http://www.metacrawler.com/</a>
Cyber 411	<a href="http://www.cyber411.com/">http://www.cyber411.com/</a>	Savy Search	<a href="http://www.savvysearch.com/">http://www.savvysearch.com/</a>

**Table 2: Selected web sites dedicated to irrigation**

Name/Category	URL	Maintained by	search engine
<b>General overview, "portal sites"</b>			
Virtual Library Irrigation	<a href="http://www.wiz.uni-kassel.de/kww/irrig_i.html">http://www.wiz.uni-kassel.de/kww/irrig_i.html</a>	Thomas-M. Stein	yes
Microirrigation Forum	<a href="http://www.microirrigationforum.com">http://www.microirrigationforum.com</a>	Richard Mead	yes
Soil water content sensors&measurement	<a href="http://www.sowacs.com">http://www.sowacs.com</a>	Bruce Metelerkamp	no
<b>Research institutes / Other organisations</b>			
Water Management Research Unit	<a href="http://www.cpri.ars.usda.gov/wmru.htm">http://www.cpri.ars.usda.gov/wmru.htm</a>	Conservation & Production Research Laboratory Bushland, Texas USA	no
Water Management Research Laboratory	<a href="http://pwa.ars.usda.gov/fno/wmrl/">http://pwa.ars.usda.gov/fno/wmrl/</a>	USDA-ARS-WRML, Fresno, California, USA	no
FAO, Land and water development division	<a href="http://www.fao.org/ag/agl/aglw/aglw.html">http://www.fao.org/ag/agl/aglw/aglw.html</a>	Water resources, development and management service (AGLW), FAO	yes
<b>Online Articles / Bibliographies</b>			
Drip bibliography	<a href="http://asset.arsusda.gov/WMRL/dripbib.html">http://asset.arsusda.gov/WMRL/dripbib.html</a>	Richard Soppe, USDA, WMRL, Fresno, California	no
Journal of Applied Irrigation Science	<a href="http://www.wiz.uni-kassel.de/kww/zfb/">http://www.wiz.uni-kassel.de/kww/zfb/</a>	Thomas-M. Stein, Peter Wolff	yes
<b>Software resources and other tools</b>			
Irrigation Engineering Software	<a href="http://www.engineering.usu.edu/Departments/bie/software.html">http://www.engineering.usu.edu/Departments/bie/software.html</a>	Utah State University, Department of Biological and Irrigation Engineering	no
IRRISOFT - Database on Irrigation and Hydrology Software	<a href="http://www.wiz.uni-kassel.de/kww/irrisoft/">http://www.wiz.uni-kassel.de/kww/irrisoft/</a>	Thomas-M. Stein	yes
<b>Professional / Industrial sector</b>			
Irrigation Association	<a href="http://www.irrigation.org/">http://www.irrigation.org/</a>	Irrigation Association, Fairfax, Virginia, USA	yes
Irrigation and Green Industry Network	<a href="http://www.igin.com/">http://www.igin.com/</a>	IGIN: The Irrigation & Green Industry Network	no

### Discussion lists dedicated to irrigation matters

The World Wide Web enables users to obtain information about many different subjects related to irrigation matters. However the situation may arise where, despite all efforts, the needed information cannot be found on the net. Or questions may arise, perhaps arising from the results of actual research work, or from reading an article. In such cases, the WWW will not help very much. An expert forum, where questions may be submitted in the hope that someone can answer these queries, may be the best approach in such a situation.

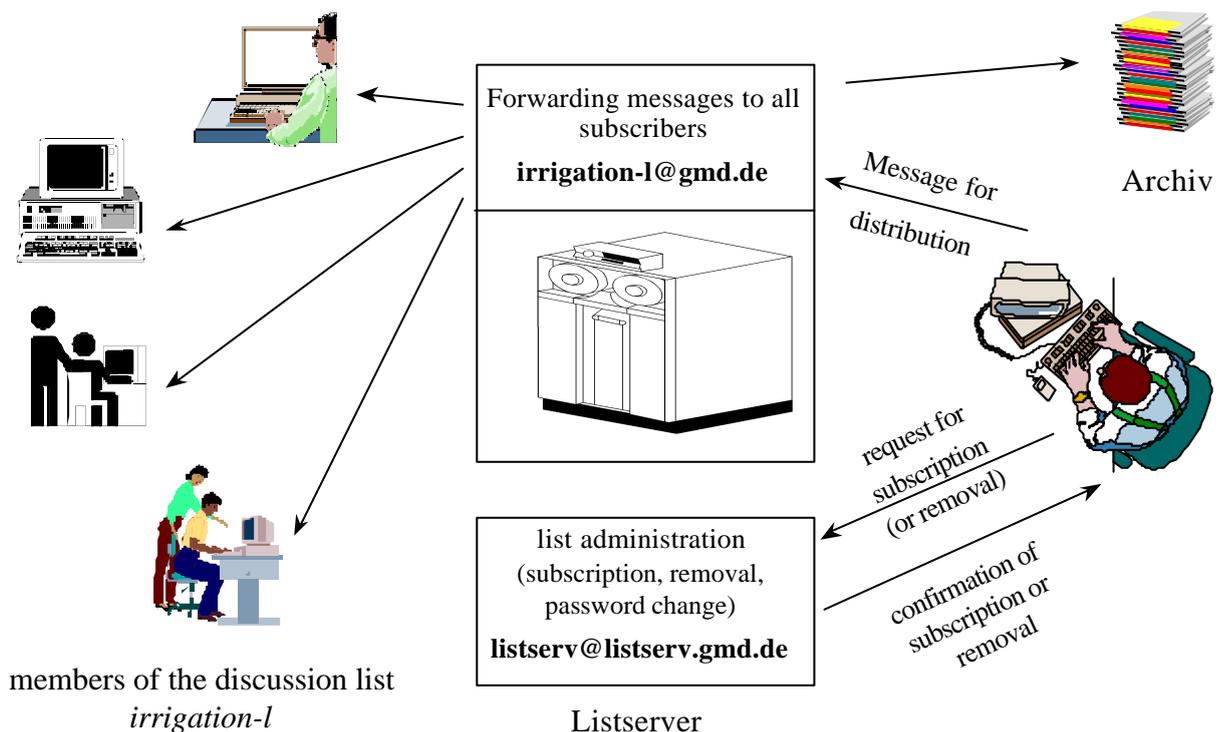
Email based Discussion lists are an ideal forum for discussions on a certain topic. Anyone with email access can participate in these discussions. The principle of such lists is as shown in Figure 2. Anyone who has subscribed to the list can contribute to the discussion, either in form of a new question or an answer, by sending an email message to the list-address (e.g. "irrigation-l") at the listserver (e.g. listserv@gmd.de") that hosts the discussion list. The listserver acts as a mere message duplicator and sends a copy of each incoming mail to each person who has subscribed to the list. With a few hundred experts in the field of irrigation as addressees, there is a high chance of getting an appropriate answer to one's request.

As listed in [8], there exist four discussion lists for irrigation that might be of interest.

The most general list is **irrigation-l** ([http://www.wiz.uni-kassel.de/kww/irrigation\\_i.html](http://www.wiz.uni-kassel.de/kww/irrigation_i.html)), others are **trickle-l** [9], **salinity-l** [12] or **sowacs-l**. A comprehensive listing of discussion lists primarily concerned with topics related to water resources, comprising of 46 entries can be found at <http://www.nal.usda.gov/wqic/lists.html>. Subscribing to a list is fairly easy, and is achieved by sending an email message to the administrative address of the listserver that hosts the list, which can be found in Table 3. The subject must be left blank, the body of the email should only contain the command *subscribe* (or: *sign off* or *unsubscribe*). A confirmation of the subscription should be promptly received.

A slightly different version of an email based information service is the land-and-water-l newsletter published by the Land and Water Development Division of the F.A.O. This newsletter is a passive means for publishing information from that division rather than a discussion list, meaning that subscribers cannot send messages directly to the service.

From each contribution to the discussion list, a copy is stored in the archives of these lists. Since these discussion lists have existed for several years, these archives are a huge information pool and a major source of irrigation information, and they have the potential to be an invaluable help in many cases. Fortunately, for most of them a full-text search-engine has been implemented. The use of these engines is highly encouraged, both before placing a question to make sure it has not recently been subject of a discussion and as a general information source.



**Figure 2:** Schematic diagram of the functionality of Internet discussion lists (example for: irrigation-l)

Table 3: Email-based internet discussion lists and newsletters in the field of irrigation

List name	per-sons	list-owner	host	founded in	Online-Archives URL	search-able
<b>Discussion lists</b>						
irrigation-l	598	Stein, T.	listserv@listserv.gmd.de	Dec. 1994	http://www.wiz.uni-kassel.de/kww/sakia/sakia_i.html	yes
trickle-l	656	Mead, R.	listserv@crcvms.unl.edu	mid 1994	http://www.microirrigationforum.com/new/archives/	yes
salinity-l	251	Soppe, R.	listserv@crcvms.unl.edu	late 1995	http://crcvms.unl.edu/archives/salinity-l.html	yes
sowacs <sup>1</sup>	n. a.	Metelerkamp, B.	majordomo@aqua.ccwr.ac.za	late 1995	http://www.sowacs.com/archives/index.html	no
<b>Newsletter</b>						
land-and-water-l	n.a.	AGLW, FAO, Hoogveen, J	mailserv@mailserv.fao.org	June 1996	www.fao.org/ag/agl/lwissues.htm	no

<sup>1</sup> soil water content sensors

### Newsgroups holding irrigation related information

Newsgroups are also an email based Internet service for online-discussions. Contrary to a discussion list, the messages sent to the newsgroups are distributed to other news servers rather than to the participants of the discussion itself. Each user can retrieve a list of the header lines from the emails sent to the newsgroup, and if he or she is interested, can request the whole document.

While newsgroups can be an extremely useful tool for solving computer hard and software problems, the chance of initiating a discussion about irrigation on a high level are pretty low. Some potentially suitable newsgroups are sci.agriculture, gov.us.topic.environment.water, sci.environment or alt.agriculture.

### Irrigation Software on the Internet

Beside information about irrigation in written form, numerous software programs of different kinds have been written which can be valuable tools both in the research and the professional area.

#### Software Catalogues

As described in [6] and [16], various approaches have been undertaken to index and summarise the various known software programs in the field of irrigation, resulting in three major inventories:

- an inventory, published in form of a book (ILRI special report, [3]);
- LOGID, an inventory in form of a database which can be accessed via a software program for microcomputers. The software including the database is distributed at no cost and can be downloaded via ftp (file transfer protocol) from the anonymous ftp-server of the university of Kassel (ftp site: ftp://ftp.hrz.uni-kassel.de/pub/irrisoft/logid). Downloading instructions can be found at <http://www.wiz.uni-kassel.de/kww/irrisoft/download.html>.
- IRRISOFT [15] - a World Wide Web database on irrigation and hydrology software that has been established and is maintained at the University of Kassel, Germany. This database lists 105 programs which are described in detail in "software description pages". The database is fully text-searchable. A few freely available programs can be downloaded from the ftp-site set up together with the IRRISOFT catalogue (ftp site: ftp://ftp.hrz.uni-kassel.de/pub/irrisoft/).

From these three approaches, IRRISOFT [14] is certainly the most promising since it relies on the internet as medium of information interchange, thereby allowing the addition of programs and modify existing entries at any time. Even an user-interface to prepare entries for submission has been created, exonerating the maintainer from translating the contents into a format usable on the WWW. With the rapid development of software and hardware technologies in mind, one can imagine that static media like that of the ILRI report or the LOGID inventory, which have not changed their contents for years neither do depict the actual state of the software market for irrigation software, nor they do represent the state of the art for the dissemination of information in such a dynamic sector like software development.

In the long term, one should expect that software is partly made executable on the WWW using the platform independent language Java. Such Java programs can be executed directly inside a web browser on any platform, thus freeing one from creating software catalogues describing the programs and their hardware requirements.

### Software programs

Not all software programs and tools are listed in the catalogues described above. A description of a choice of programs can be found at [10]. A variety of other web sites are also offering various software programs or tools or will present links to such applications. Surely one of the most comprehensive sites for software programs in the irrigation sector is maintained at the Department of Biological and Irrigation Engineering at the Utah State University, USA (<http://www.engineering.usu.edu/Departments/bie/software.html>). Altogether 24 programs are listed, 17 of them for DOS-platforms, the other seven are Windows programs. While five of the products are distributed at no cost, the prices for the other programs range between 15 and 3.500 US \$.

The Water resources, development and management service of the Land and Water Development Division at the FAO offers various tools at their site <http://www.fao.org/waicent/faoinfo/agricult/agl/AGLW/dss.htm>, amongst them the software program CROPWAT (for DOS and Windows) and the climatic database CLIMWAT. The microirrigation research group at the New Mexico Climate Center offers links to various programs and Excel-Spreadsheets at the URL <http://weather.nmsu.edu/w128/>. The Water Management Research Lab inside the Agricultural Research Station of the USDA offers its products at <http://pwa.ars.usda.gov/fno/wmrl/software/index.html>.

## How to offer irrigation related information at the Internet?

Having all the advantages of the new internet technologies in mind, one might think of getting actively involved in disseminating information on the web. All companies or organisations working in the field of irrigation which are already present on the Internet, are highly encouraged to register their institution to the Virtual Library of Irrigation. An online accessible form for the automated creation of an entry in the virtual library based on the user input is available at this site. It can be found at [http://www.wiz.uni-kassel.de/kww/projekte/irrig/add/add\\_s.html](http://www.wiz.uni-kassel.de/kww/projekte/irrig/add/add_s.html). Applicants have to specify some data about the institution and what is offered on the web page and they can deliver a short abstract that describes their site and the information held there. After submission, applicants promptly will receive an email, indicating the temporarily URL of a created web page based on the contents that were submitted. If not content with the resulting page one can make proposals for corrections, otherwise the created page will be

added to the Virtual Library Irrigation after being approved by the maintainer of the site.

In order to publish own contents on the WWW, like findings of recently conducted research work, users should contact their system administrator. Designing own web pages and putting them on a server is not as complicated as it is thought to be. If there is no opportunity to publish on the servers of the institution one is working with, everyone has the opportunity to get free web space which is offered from several companies (have a look at <http://freeweblis.freeservers.com/> for further information).

## **Global efforts to improve the access to the Internet**

The "information world" is dramatically changing as electronic means become more and more widespread and it seems obvious that internet-based technologies will gain even more importance in the near future. This position is held by the Advisory Committee of the U.S. Federal Networking Council which firmly believes "that the Internet is a critical resource for the national research and education communities. This resource should be made available to the widest possible customer/user base with the highest possible level of service" [3].

As well as all the positive statements, some negative effects may also need to be considered like those stated by ARUNACHALAM (1998), i.e. that history has also shown that technology inevitably may enhance existing inequalities and thus widen the gap between industrialised and developing countries. Despite the enormous general growth of the Internet the availability of scientifically valid and approved information is disproportional low and far from being sufficient to meet the steadily increasing demand and growing expectations, especially concerning developing and less developed countries. Great efforts have been made over the last few years by international and national organisations, universities and individuals to improve the availability of information and access with several examples mentioned above. While there have been some impressive efforts, many users still have difficulty in accessing the full range of information on water conservation in agriculture.

As stated by SEIBEL et al. (1999), the private sector and international development agencies still appear to underinvest in information and communication technologies (ICT) in low income countries. For many developing countries the financial and technical constraints on accessing the Internet still form the major hindrances to accessing adequate and high quality information. To improve the communication and Internet facilities in developing countries, more than eight major programs funded by international organisations have been started. With regard to the African continent, for example, two major projects will establish a sound starting basis for an African wide connectivity which potentially covers the entire continent and should be established this year. The geo-stationary communication satellite above the area of Lake Victoria, which covers the entire African continent and the Indian subcontinent, and the laying of high speed and high capacity undersea fibre-glass cables surrounding the entire African continent allows 32 coastal countries to be linked up.

So we can expect that the situation in these countries will improve in the near future, giving them broader access to information that hopefully can be disseminated to allow the further development of their nations.

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## **Land Reclamation in Egypt - a critical external review**

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### **Introduction**

The area of the Egyptian state totals about 1 million km<sup>2</sup>, 96% of which is desert and barely 4% is cultivated land. This means that c. 40,000 km<sup>2</sup> are available as effective Lebensraum for its approximately 63 million inhabitants. Restricted predominantly to the Nile Valley and the Nile Delta, this cultivated area is one of the most densely settled areas on earth, carrying more than 1,575 inhabitants per km<sup>2</sup>. The scarcity of living space in this country is even more striking when seen in the context of the effectively managed area used for agriculture. With an agricultural utilised area of altogether 2,607 million hectares, at present about 0.048 hectares of agriculturally used area is available per inhabitant. For years Egypt has been presenting an almost explosive population growth, with a growth rate of around 2.8% p.a. Recently the growth started to decline. What is giving cause for concern is the fact that for years the growth rate of agricultural production, especially foodstuffs, has not kept pace with the population growth. Increased agricultural production has therefore represented the most important economic policy aim of all Egyptian governments since the 1952 revolution.

A rise in agricultural production in Egypt can be achieved by raising the cultivation intensity (by intensification of irrigation, fertilising, plant protection, drainage etc.) and by raising organisational intensity (like substituting tuber crops and vegetables for grain), as well as through extending the agricultural area by cultivating part of the huge desert area. Over past decades Egypt has sought to make use of all three of these options for raising agricultural production, with the government making particular efforts in the field of desert cultivation and opening up of new land. The latter tend to involve expansion of the agricultural area into desert areas, i.e. into a natural area which is difficult to manage. In what follows, the history and the development problems of the newly reclaimed areas will be presented and analysed - not only in order to explain the difficulties Egypt meets with in its endeavours to expand the scope for food growing, but above all in order to draw attention to the problems in general which occur today with the expansion of the agriculturally utilised areas, even in over-populated agricultural countries.

### **The history of desert cultivation and the reclamation of new land in Egypt**

In Egypt efforts to open up new land have a history that reaches back into antiquity. These efforts tended to concentrate in the valley and delta of the Nile, or on directly adjacent areas. In the last two centuries in particular attempts were made to reclaim land for agricultural use through perennial irrigation and drainage measures.

### **Measures to reclaim new land up to 1952**

In the early 19th century the agriculturally used area of Egypt included c. 2 million feddans (840,000 hectares), c. 250,000 feddans (c. 105,000 hectares) of which were restricted to summer use only. Under the regency of Mohammed Ali efforts to reclaim new land and to extend field use in summer were markedly intensified. Already in about 1830, c. 600,000 feddans (c. 250,000 hectares) were also available for summer use and in 1848, by the end of Mohammed Ali's regency, the agriculturally used area of Egypt had risen to c. 2.6 million feddans (1,092,000 hectares). During that time efforts to open up new land were concentrated above all on the amelioration of saline clay soils in the northern delta between the two arms of the Nile. With the help of more or less forced labour the government mainly constructed irrigation canals and main drainage channels, whereas the opening-up of the individual plots was left to private initiative. Attempts to cultivate the desert remained modest, and the results questionable, especially in the oases of the Western Desert (Busche, 1979; Meyer, 1978; Wolff, 1983).

In the third quarter of the 19th century, measures to reclaim land in the northern delta not only continued, but at the same time were extended to include central Egypt as well. In the year 1880 approximately, the agriculturally utilised area had increased to c. 4.7 million feddans (1,974,000 hectares). By the end of the 19th century, additional investments in the irrigation system, especially in the construction of delta barrages, had led to an increase in the agriculturally utilised area to c. 5.2 million feddans (2,184,000 hectares).

In the beginning of the 20th century the construction of a barrage, the building of various feeder canals in central Egypt, and the completion of the first Aswan dam, the level of which was raised twice - though only leading to a modest increase in the area under cultivation-, nonetheless had the effect of a marked intensification of the utilisation of the available area, chiefly by expanding the area under perennial irrigation. However, construction of a drainage system of appropriate dimensions, matching those of the measures described above, was omitted. This resulted in increased occurrences of fields becoming marshy and salty, and to a subsequent reduction in the productivity per feddan. From the turn of the century to the 1952 revolution measures to reclaim new land only succeeded in extending the agriculturally utilised area of Egypt by c. 125,000 feddans (c. 52,500 hectares). The major part of this area was opened up by private investors. The government mainly concentrated on the completion of the drainage network during the period (Hopkins et al., 1988; Wolff, 1980 and 1986).

### **Measures to reclaim land and cultivate desert areas since 1952**

The revolution of the year 1952 presents a turning-point in the governments policy towards land reclamation and desert cultivation. In post-revolutionary Egypt the relatively small area available for agricultural utilisation and the rapid growth of the population resulted in according high priority to the opening-up of new land. In this, the corresponding government measures were often directed primarily towards the physical reclamation of new land for cultivation, whilst neglecting the necessary raising of productivity by of plot amelioration measures. The occurrence of a food deficit in the late-60s, which deepened steadily in the following decades, together with the negative agricultural trade balance as a consequence of this deficit, led to special attention always being paid to the opening-up of new land in the following years and up to the present.

In recent decades the definition of the term "reclamation" or "new land development" has undergone several changes. In its comprehensive form the term describes the development of the entire infrastructure affecting production, the development of village social and physical infrastructures, as well as the improvement of soil fertility to so-called positive marginal productivity. The comprehensive development package has been slimmed down several times in the course of recent decades. Even the concept and philosophy of the policy of new land reclamation has undergone several amendments, or even fundamental change. In the 1950s priority was given to the provision of land and the improvement of the living conditions of the growing proportion of landless people among the population. Raising agricultural production was seen as being of comparatively secondary importance. In the early days of the post-revolutionary new land reclamation, co-operative or mutually beneficial forms of land use were attempted in the new land areas. Entirely novel, "modern" forms of rural society were to be created. Expectations were very high: extremely ambitious, large-scale programmes for the opening-up of new land and extending over an area of c. 1 million feddans were decided upon and tackled. In reality, however, only 80,000 feddans were reclaimed in the period up to the late-fifties. Co-operatives, which took over the distribution of land and the means of production, as well as the buying of production means and the marketing of produce, were set up; However, co-operative or mutually beneficial farming was not introduced (Voll, 1980; Wolff, 1983; Hopkins et al., 1988).

In the sixties, until the war with Israel in 1967 to be precise, the new land reclamation made good progress. The construction of the Aswan High Dam in particular had a stimulating effect. Admittedly, the corresponding efforts were substantially directed towards the actual work of reclamation, whilst the transformation of the reclaimed areas to permanently productive cultivation areas was not undertaken with the requisite emphasis. A large part of the reclaimed area was run as state farms with an army of workers, or remained in the care of national development companies. During this phase, areas not exceeding 5 feddans were leased to peasants, but rarely turned over to them. In principle, however, it was assumed that large state farms were better suited to mechanised cultivation of the land and better placed to obtain foreign exchange by careful management of fruit and vegetable production for export. This change in policy of land reclamation influenced not only the new schemes, but also affected the areas which - though reclaimed - had not yet been assigned to those peasants for whom they had been originally intended. Henceforth the aim of land reclamation was no longer to meet the wishes of landless people for a small plot of their own, but to expand agricultural production and grow marketable surpluses, thereby increasing state revenues and above all foreign currency earnings.

In the years up to 1966 a total of 307,000 hectares of new land was opened-up to cultivation in various parts of Egypt. Most of these areas - 122,500 hectares - were in the Nile areas, followed by Tahir Province with 62,500 hectares, and the desert areas with 59,900 hectares. Other major foci of new land reclamation during this period were in Upper Egypt, in the so-called Nubian Settlement Area (16,300 hectares) and in the districts of Kuta, Kom Ashim and Abis (15,200 hectares). Official statistics for the period up to 1966, moreover, include wasteland (30,900 hectares) in all parts of the country which had been brought back into cultivation by reclamation (Wolff, 1983).

After 1966 the area of newly reclaimed land in Egypt increased at first only slightly, and almost exclusively in the Nile area, where a further increase of around 70,000 hectares had been registered by 1974. The main reason for the slow-down, or even

standstill, in the opening-up of new land are thought to be the military conflicts with Israel in the year 1967 and the subsequent years of economic recession (Meyer, 1978).

In 1975 the reclamation of new land reached its peak after the 1952 revolution, when a total of 411,000 hectares had been reclaimed; but it also reached its first critical phase, since only about 259,000 hectares, i.e. 63% of the reclaimed area was agriculturally used. Even the further development of the actually utilised areas proved to be quite problematic. In almost all the new land areas it took a disproportionately long time to reach even marginal productivity - that is, a production level at which the cost of production is covered by the resulting yields. Not inconsiderable parts of the new land areas have still not reached even marginal productivity.

In the seventies the reclamation of land was restricted to the completion of the on-going projects; next to no new projects were started. However, the policy of opening-up new land, i.e. the distribution and utilisation of areas already reclaimed, once again underwent change at this time. The low productivity of the state farms showed that under Egyptian conditions large state farms were evidently unsuited to the management of new land areas. The intensive cultivation of the new land areas by peasants, and the higher yields produced by them, led to a return to greater peasant-orientation in respect of opening-up and, above all, distributing already reclaimed areas. Attempts to retain state farms for the production of high quality fruit for market of fresh produce and industrial processing were confined to the western delta and the adjacent areas. At the same time a programme was set up in the mid-seventies, which made land for individual cultivation available to graduates.

In the Spring of 1978, the Egyptian government, notwithstanding these and other problems, announced the start of a "Green Revolution" for the country. Besides increased intensity of cultivation, this "green revolution" aimed at substantial expansion of the agricultural area. In a highly euphoric estimate of the production potential of Egyptian desert areas and the useable water resources, the "Egyptian Master Water Plan" provided for an expansion of the agricultural area by the year 2000 of about 1.24 million hectares, i.e. by about 44% of the area under cultivation in the early-eighties (Samaha, 1980). If this goal was to be reached c. 62,000 hectares of new land per year would have had to be opened up. Considering the fact that in the first phase of new land reclamation (1952 - 1966) an average 20,000 hectares were reclaimed per year, and that the areas available for reclamation in the late-seventies were much more difficult to open up, the Egyptian ideas as set out in this plan did not seem very realistic. Furthermore, the development problems of areas hitherto reclaimed could in no way be regarded as solved (Hopkins et al., 1988).

Thus, after a period of resignation in the seventies, new efforts were made to expand the Egyptian agricultural area. The announcement of the so called "Green Revolution" by the Egyptian Government is seen as a turning point in reclaiming new lands. That's why lands reclaimed before 1978 are termed "old new lands", while the post 1978 reclaimed lands are known as the "new new lands". From 1978 onwards the opening-up of new land formed an essential part of various five year plans, and almost 40% of the total investments of the agricultural budget were set aside for this field. However, due to financial bottlenecks in the country's budget, it became more and more difficult to fulfil the planing states from one year to the next. The actual expenditure in the period 1982/83 to 1986/87 turned out to be only 50% of that budgeted for new land reclama-

tion. In the period 1978 - 1988 the area of newly reclaimed land increased by 242,634 hectares, i.e. by c. 24,000 hectares a year. The original goal of 62,000 hectares a year was not reached. The five year plan for 1987 - 1992 had envisaged the opening-up of a total of 315,000 hectares. 14,700 hectares of this were situated in the so-called "New Valley", and are to be irrigated with groundwater. 300,300 hectares were scheduled to be irrigated with Nile water. By the year 1997 1,092,000 hectares had been reclaimed since the beginning of the fifties, but still only 672,000 hectares were under agricultural production at that time.

In the context of the drawing-up of the so-called "Land Master Plan" in 1986, 2.6 million feddans (1.09 million hectares) were identified as suitable for reclamation under certain conditions. 997,000 hectares of these require water supplies from surface waters, i.e. the Nile, whilst 92,000 hectares are thought to be within reach of groundwater reserves. The Egyptian government aims at present to open up 1.43 million hectares up to the year 2017 and from thereon an other 2.18 million hectares; though the question of where the water for irrigation of these areas is to come from remains. The question will be addressed in greater detail below. For the present, the fact is to be noted that, in the face of the dramatic population growth in Egypt, the opening-up of the new land will for the foreseeable future continue to play an important role in the framework of Egyptian agricultural policy. This was among others stated in a more recent speech by President Hosni Mubarak on the launching of the Upper Egypt New Delta Project. In his speech President Muhammad Hosni Mubarak pointed out that "It is time for Egypt to be released from captivity within the narrow valley to stretch out into the vast expanse of its entire territory, in pursuit of a better tomorrow, gleaming with hope for all Egyptians." And in the Egypt State Information Service Web Site "Egypt in the 21<sup>st</sup> Century - Vision 2017" the following is stated under the heading "Development Strategy Outline" as the first development objective:

*Extend the scope of development to the entire area of the country, explore its wealth and provide opportunities for settling millions of Egyptians outside the narrow valley, which accounts for maximum 5.5% of the total area of the country, thus raising the ratio of inhabited space to 25%. The next twenty years represent an important phase for such expansion. Areas rich in national resources are to be opened, and increasingly utilized, population is to be settled down at locations which will be integrated and interlinked in the long run.*

Making use of the fast desert areas will stay high on the agenda in Egypt for the years to come, despite the limitations of expanding agricultural activities into the desert.

## **Perspectives for the future**

Considering the limitations of the world's agricultural area, Andrae (1977) in his *Agricultural Geography* notes that "with expectation of rising income and living standards, higher agricultural yields are necessary. And this is why in the course of development, land which has been regarded until now as fairly productive will become marginal land, and previously marginal land will go out of production". The application of this general statement to the Egyptian case confirms the fact that agriculture already displays a tendency to withdraw or to stay away from marginal locations. The abandoning of cultivated land in the Wadi El-Natron (Wolff and Bliss, 1980) and the fact that some of reclaimed land does not reach marginal productivity is an unambiguous example of this.

The growth rate of private measures for land reclamation which, to name just a few examples, occurred along the Cairo - Alexandria desert road, in Nubaria, in the countryside around Cairo and elsewhere, does not contradict this development trend. Many of these private reclamation measures are the result of speculative considerations and the very high prices for agricultural property in Egypt, although numerous investors have been complaining in Egypt for some years about the inadequate profitability of the farming activities within the reclamation schemes. Even with crops of relatively high market value (fruit, vegetables), it is exceedingly difficult to achieve sufficient profitability in the predominantly marginal areas. In addition there is a relatively high capital requirement for water supplies and distribution at farm level as well as for the improvement of the fields. It is an open question whether the investors will keep interest in new land developments on a medium and long term basis. Because of the apparent success of some large scale and highly specialised farming operations in new land areas this farming systems are seen as the future for the development of Egypt's new lands.

Since the marginal locations of agricultural production in Egypt tend to be new land areas, the development outlined above runs counter to the government's policy of land reclamation and to the euphoria of private investors over recent years. By contrast with those in the old lands, unalterably low yield levels in most new land areas do not raise expectations that these areas will ever become, in the long term, fully adequate locations. They will in comparison to the Nile Valley and Nile Delta always remain marginal locations, and it is to be expected that they will cease to be competitive in the course of further economic development or be forced to rely on high state subsidies to survive. The latter already applies to the majority of the sub-projects of the New Valley as it does to many other new land areas. Every further new land reclamation in Egypt contains, at least potentially, the danger of a rise in state subsidy payments for the new land areas, and thus of the withdrawal of state investments in areas of the Egyptian economy which have development potential.

In Egypt agriculture may retreat to the most productive locations, which in accordance with Andrae's hypothesis is to be expected; in connection with the rise in the cultivation intensity it may also come up against a limiting factor in respect of the limited scope to expand food supply given the explosive growth of population.

Due to the surplus on the world's agricultural markets and the relatively low price levels, as well as high qualitative demands, it cannot be expected that Egypt will succeed in exporting agricultural products on a large scale, and thereby making land use in the new land areas more profitable. In view of this fact the author suggests the following three measures for raising the agricultural and the overall economic capacity as being of greater importance for Egypt than the reclamation of new land:

- improving and sustaining the production capacity of the old land areas through measures affecting cultivation techniques, the agrarian structure and the sustainability of the natural resource base;
- opening-up and developing alternative branches of the economy, i.e. especially in industry and services;
- increasing investments in human development as the Egyptian people are the most valuable resource of the country.

## Limitations of new land reclamation in Egypt

### Limiting factors

New land reclamation in Egypt has its limits, especially in regard to the availability of fertile soils and suitable water resources (Wolff, 1992). Although land seems to be abundant, properties and fertility of the newly reclaimed soils and of the ones left for reclamation are marginal. Most of the newly reclaimed soils are sandy and calcareous. Sandy soils are structureless. Field capacity and wilting point are low (8 - 9 and 2 - 3% of soil moisture content, respectively), and the soil is poor in organic matter, and the macro- and micronutrient content is low. The average pH value is 7.7, and EC values range between 0.2 and 0.5 dS/m. Calcareous soils have totally different chemical and physical properties. They are high in CaCO<sub>3</sub> content (26 - 59%) while organic matter percentage ranges between 0.23 and 1.50. The cation exchange capacity is relatively higher than that of the sandy soils and pH values are between 7.8 and 9.6. The EC is less than 4 dS/m (Bedier et al., 1998).

Water resources to reclaim the vast desert lands of Egypt represent the most critical constraint. As mentioned above: Egyptian agriculture depends entirely on a fixed supply of water annually from the River Nile, while groundwater is limited in quantity and quality at certain locations. Egypt's expected water balance in the year 2000 has been calculated by Abu-Zaid (1989) on the basis of a continuation of the Water Master Plan (Table 1).

Egypt's water balance, as presented in Table 1, shows reserves of 1.7 billion m<sup>3</sup> in 1990/91. It is doubtful whether all of these reserves have actually existed, as not all of the new new land hitherto reclaimed had reached full productivity, and consequently it had not called upon the full amount of water which had been earmarked for them.

Table 1. Water balance for the Arab Republic of Egypt in the years 1990/91 (actual) and 2000 (expected)

	1990/91 (actual) billion m <sup>3</sup>	2000 (expected) billion m <sup>3</sup>
Available water supply	55.5	55.5
Release Aswan High Dam	53.8	
Contribution Upper Nile Projects		2.0
Evapotranspiration	36.6	38.9
Domestic use, industry <sup>1</sup>	1.5	4.8
Evaporation losses	2.0	2.7
Drainage to the Mediterranean	12.1	11.8
Shipping, water power	1.6	0.3
Surplus	1.7	-1.0

<sup>1</sup> non-recyclable water; actual requirements are much greater

Source: Abu-Zaid, 1989; v.d. Molen, 1997

In future, it might become increasingly difficult to satisfy the actual demand for water, especially if the ambitious policy of the Egyptian government to reclaim new land is carried out as planned, and hitherto reclaimed areas are fully utilised. As it cannot be assumed that the Jonglei Canal Scheme in the Southern Sudan will be operating by the year 2000, or that the so-called Winter Water Project will be effective, i.e. that the unexploded discharge of 2.8 billion m<sup>3</sup> can be calculated for the year 2000.

### **Some thoughts on agricultural water use in Egypt under special consideration of new land developments**

To judge the availability of water for an encroachment of Egypt's irrigated agriculture into the unexploded desert areas of the country a calculation, based on a similar calculation of van Leeuwen (1997), was carried out with the following results.

#### *Irrigation water requirements under special consideration of further new land developments - Irrigation requirements of new land developments*

The net evapotranspiration of an average cropping pattern in the Nile Delta amounts to 1,200 mm/year. The cropping pattern in New Valley is supposed to be adapted to desert environment and will exclude crops with a very high consumptive use. However, this will still be offset by higher temperatures and advection (horizontal heat flux from desert to arable land) that will increase the evapotranspiration rate with about 10 to 20%

**Assumption 1:** Evapotranspiration in New Valley: 1,600 mm/year  
Net water consumption of 1 feddan: 6,700 m<sup>3</sup>/feddan/year

Surface irrigation water from lake Nasser contains 250 mg/l total dissolved salts. The maximum permissible salt concentration in soil moisture is 2,500 mg/l (Ece = 4 dS/m). This requires a leaching ratio of  $250/2,500 = 10\%$ .

**Assumption 2:** An additional 700 m<sup>3</sup>/feddan/year has to be supplied for leaching

Evaporation losses from open canals, field ditches and spill areas are estimated to amount to 5 % of the net irrigation application (evapotranspiration + leaching fraction).

**Assumption 3:** An additional 300 m<sup>3</sup>/feddan/year has to be supplied to cover unavoidable evaporation losses.

It is assumed that only modern irrigation methods and distribution systems will be applied in the New Valley Project. This will include provisions to recirculate tail losses and other spills from the supply network.

**Assumption 4:** The gross irrigation supply for one feddan amounts to the sum of the three above mentioned requirements being a water duty of: 7,700 m<sup>3</sup>/feddan/year.

During the first stage of the Project, some 500,000 feddans will be reclaimed for irrigated crop production.

**Assumption 5:** Annual water supply for 500,000 feddans amounts to 3.85 billion cubic metres.

**Assumption 6:** Irrigation of 500,000 feddans in New Valley will generate 350 million cubic metres drainage water, with a salinity that is too high for other uses. This drainage water will either percolate to the groundwater, or has to be disposed of in a drainage sump of the same size as the Wadi Rayan Lakes (120 – 150 km<sup>2</sup>).

*Proposed conjunctive use of groundwater*

The present abstraction of groundwater from the Nubian aquifer in the New Valley is estimated at 1 billion cubic metres per year. According to studies of the Groundwater Research Institute of Egypt's Water Research Centre, the potential abstraction could be about 2 billion cubic metres per year. It is proposed to use the additional 1 billion cubic metres of groundwater in the presently reclaimed areas only during the peak periods in irrigation demand. This means that during the summer season conjunctive use of surface- and groundwater will be applied and that during the winter season only surface water will be applied.

The application of this option might result in the reduction of the canal capacity and thus saving considerable investments.

*Effect on the water and salt balance of the Nile Valley and Delta*

At present, the Aswan release is 55.5 billion cubic metres per year. This water carries a saltload of 14 million tons of dissolved salts. It is estimated that an additional 1 – 2 million tons of salt is added from agricultural chemicals, industrial waste and domestic effluents. In the northern fringe of the Delta an unknown quantity of salt enters the hydrological system through seawater intrusion.

The Drainage Research Institute Reuse Project estimated that a total saltload of 20 million tons has to be evacuated to the sea per year.

**Assumption 7:** When the salt concentration of percolation water (leachate) or other drainage effluent exceeds 2,500 mg/l, then it will not be recoverable for reuse and must be discharged to the sea, or other safe disposal sites.

**Assumption 8:** Disposal of 20 million tons saltload requires a minimum drainage flow to the sea of 8 billion cubic metres per year.

With the current 55.5 billion cubic metres the following water allocation can be realised:

Net domestic consumption	2.5	billion cubic metres
Net industrial consumption	2	billion cubic metres
Unavoidable evaporation losses	2	billion cubic metres
Saltload disposal to sea	8	billion cubic metres
Net evapotranspiration of crops	41	billion cubic metres

**Assumption 9:** The potential area for crop production, based on the availability of 41 billion cubic metres and a net evapotranspiration of 5,100 cubic metres per feddan and year amounts to 8.0 million feddan.

The present net cropped area is estimated at 6.8 million feddan. It should be noted that many of the new reclamation areas did not yet realise their targets and have only between 50 and 70 percent of the designated area under crop production.

The planned expansion of reclamation areas in Sinai (240,000 feddans), West and East Delta (360,000 feddans) and completion of the areas in existing reclamation projects (200,000 feddans) will result in a total cropped area of 7.6 million feddans. This leaves only a potential of 400,000 feddans for future expansion.

Water savings, made through improvements in the irrigation system do not contribute to additional water resources. The only real saving that can be made is the reduction of non-productive losses from evaporation. Reduction of tail-end losses, percolation losses and surface run-off result in almost the same reduction of drainage water. On the other hand, the reduced dilution of drainage water with irrigation losses, will result in a higher salinity of the drainage water.

With respect to the proposed savings from rice and sugar cane, only the lower net evapotranspiration of the substitute crops should be accounted and not the difference in gross water duty. The evapotranspiration rate of rice and sugar cane is about 1.4 times more than that of alternative crops.

**Assumption 10:** The proposed conversion of 800,000 feddans rice and sugar cane to other, less demanding crops could result in a decrease of evapotranspiration of some 450 mm/year, corresponding to a total water saving of 1.5 billion cubic metres per year.

It remains doubtful, that farmers will accept the reduction of their rice area. The government has no capacity to enforce their decision on cropping patterns, like 10 years ago. The solution of this problem should be a rather radical one: Revoke the import ban on rice and sugar and import large quantities of cheap rice from S.E. Asia and sugar from America, in order to swing the market to an over-supply situation.

#### *Future situation*

Abstraction of 6 billion cubic metres for New Valley has the following impact on the water and salt balance of the Nile valley and delta.

Salt loads: Influx of salt at Aswan will be reduced with 1.5 million tons. Total salt load to be disposed of (including seawater intrusion): 18.5 million tons at a concentration of 2,500 mg/l, requires a drainage flow of 7.4 billion cubic metres.

Assuming that the net water saving from rice and sugar cane can be partially realised, some 1 billion cubic metres will be available. Without rice and sugar cane, the net evapotranspiration of the average cropping pattern will be about 5,000 cubic metres per feddans and year.

For the short-term it is assumed that domestic and industrial consumption remains the same amount.

Substituting these new figures in the water balance results in an availability of 36.6 billion cubic metres for net crop evapotranspiration.

**Assumption 11:** In the new situation some 36.6 billion cubic metres available for net evapotranspiration could sustain crop production in some 7.4 million feddans in the Nile Valley and Delta.

**Assumption 12:** The developments in Sinai and reclamation schemes in West and East Delta are jeopardised if the proposed abstraction of 6 billion cubic metres is released. The limit of abstraction for New Valley should not exceed 4.5 billion cubic metres.

Development of the additional groundwater potential will add 1 billion cubic metres per year. About 50% of this water could be used for domestic and industrial consumption, while the other 50% is for conjunctive use during the winter season.

**Assumption 13:** The total net available supply for crop production in the New Valley will not exceeded 5 billion cubic metres per year, including groundwater. This amount limits the irrigated arable land to 740,000 feddans.

## Concluding remarks

All this implies that, according to the present state of knowledge, a marked water shortage is to be expected in Egypt in the years to come. Though the calculation of the water balance deficit above was based on the assumption that the discharge conditions of the Nile will not change in the foreseeable future, i.e. that the other countries bordering on the Nile will not draw larger quantities of water, in which case the water deficit in Egypt would be even more severe.

The water balance presented above and the calculation carried out show that it is an illusion to believe that the Egyptian agricultural area can be expanded to the planned extent, especially since it cannot be assumed that the other states sharing the Nil will agree to a substantial increase in the drainage of Nile waters through their canalisation and wetland drainage. Moreover, Egypt has no groundwater resources which could be renewed by natural precipitation.

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## **Veterinary Medicine (Groups Hathor and Apis)**

### **Bericht über parasitologische Forschung in Ägypten**

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Acht Kurzzeitdozenturen an vier Tierärztlichen Fakultäten in Ägypten (Beni Suef, Cairo, Edfina, Kafr El-Sheik) wurden dazu genutzt, neben der Lehre zusätzlich mit verschiedenen ägyptischen Kollegen eine Reihe von parasitologischen Forschungsprojekten durchzuführen. In diesem Bericht wird allgemein aufgezeigt, wie sich eine fruchtbare Zusammenarbeit zwischen verschiedenen Personen und Institutionen letztendlich darstellen sollte.

Bei **Equiden** war uns die Verbreitung von Gastrodiscus aegyptiacus wichtig, einem im Darm lokalisierten Trematoden, der weitgehend nur in afrikanischen Ländern und auf Madagaskar vorkommt. Für Dictyocaulus arnfieldi hat sich in Untersuchungen von Norden (Kaluobyia) nach Süden (Aswan) bestätigt, dass der Esel den Hauptwirt darstellt und dieser Lungenwurm im Maultier sowie Pferd weniger anzutreffen ist. Kenntnisse zum Befall von Eseln und **Wiederkäuern** (Rind, Wasserbüffel) mit Fasciola gigantica erschienen uns deshalb relevant, weil in Ägypten Leberegel-Infektionen beim Menschen bis zu 43% vorkommen sollen. Bezüglich des Infektionsrisikos für die Bevölkerung hielten wir weiterhin bei **Fleischfressern** vergleichende Untersuchungen (Ägypten, Türkei) an Hunden über Toxocara canis (Larva migrans visceralis) und Ancylostoma caninum (Larva migrans cutanea) für sinnvoll. Der Magenwurm der Katze, Ollulanus tricuspis, war in Ägypten nicht bekannt. Er wurde aber nur übersehen und von uns vor 15 Jahren erstmals bei Katzen in Ägypten bzw. auf dem afrikanischen Kontinent entdeckt; inzwischen ergab sich bei streunenden Katzen (Cairo, Behara) eine Infektionsrate von 27,1%.

Detaillierte Daten findet man bereits in verschiedenen Publikationen dokumentiert, die der speziell daran Interessierte der nachfolgenden Aufstellung entnehmen kann:

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## **Fate of enterohaemorrhagic Escherichia Coli O157:H7 in buffalo's milk and some of its manufacturing products**

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### **Summary**

The present study was conducted to trace the survivability of *E. coli* O157:H7 in raw and pasteurized buffaloes' milks, yoghurt and Damietta cheese. The results revealed that the organism populations in raw milk of  $8.34\text{-log}_{10}$  cfu/ml initial inoculum stored at  $22\pm 2^{\circ}\text{C}$  increased slightly through the first day, then decreased gradually from  $9.5\text{-log}_{10}$  cfu/ml at the 2<sup>nd</sup> day to  $2.35\text{-log}_{10}$  cfu/ml at the 10<sup>th</sup> day. It could survive at higher counts in the refrigerated raw milk achieving  $5.74\text{-log}_{10}$  cfu/ml by the end of the same holding period. In the pasteurized milk, the tested organism undergone continuous regular decrease from  $7.86\text{-log}_{10}$  cfu/ml at 0 time to  $1.4\text{-log}_{10}$  cfu/ml by the end of the 30 days holding period. In yoghurt, the pathogen survived for 8 days at refrigerated

storage following its preparation. However, its populations reduced from  $8.23\text{-log}_{10}$  cfu/ml at inoculation time to  $1.8\text{-log}_{10}$  cfu/ml at the 8<sup>th</sup> day. The pH of the product was 4.12 and reached 4.06 through the corresponding period. Concerning the three manufactured cheese varieties (LS, MS and HS), the organism populations decreased sharply during the curd formation, started to increase during the draining period and through the first 4 days of storage at  $22\pm 2^{\circ}\text{C}$  and returned to decrease again through the rest of storage term achieving  $2.76\text{-}$ ,  $3.4$  and  $0.0\text{-log}_{10}$  cfu/ml in LS, MS and HS cheeses, respectively. For cheeses held at  $4\pm 1^{\circ}\text{C}$ , the organism persisted at considerably higher counts achieving  $7.11\text{-}$ ,  $4.08$  and  $4.15\text{-log}_{10}$  cfu/ml in the 3 cheese varieties, respectively. The inhibitory effect of the high salt percentage on EHEC was more pronounced than that arising from the lowered pH values in all the 3 cheeses. The public health significance of the tested pathogen as well as suggestions for its exposure avoidance via consumption of foods, particularly dairy products, were discussed.

## Introduction

Since 1920s, *Escherichia coli* (*E. coli*) has been isolated from dairy products with variable incidences and counts. Some of its serotypes have been involved in outbreaks of human gastroenteritis (Aureli et al., 1992). As the organism is commonly present in gastrointestinal tract of animals and man, many types of foods including meat products, fish, milk and dairy products, vegetables, baked products, and water would be hazardous if exposed to direct or indirect contamination with faecal materials carrying it, along with improper storage temperature and inadequate heat treatment. As a result, these foods have been associated with gastroenteritis of *E. coli* origin in many countries (Kornacki and Marth, 1982 and Garvani, 1987). The term enteropathogenic *E. coli* has been used rather indiscriminately in the past for strains of *E. coli* which cause infantile diarrhea by different mechanisms (Moon et al., 1979). More recently, it was shown that diarrheogenic *E. coli* strains are now classified on the basis of clinical symptoms, mechanisms of pathogenesis and in some instances, biochemical and serological markers into five categories: enterotoxigenic (ETEC), enteroinvasive EIEC), enterohaemorrhagic (EHEC), enteropathogenic (EPEC) and enteroaggregative-diffuse adherent (EA<sub>g</sub>-DAEC) (Donnenberg and Karper, 1992; Gomez et al., 1989 and Giron et al., 1991).

EHEC (O157:H7) has received recently a considerable attention, as it was implicated in several outbreaks of gastroenteritis, with several cases developing haemolytic uremic syndrome (HUS), haemorrhagic colitis (HC) and thrombotic thrombocytopenic purpura (TTP). Raw milk (Martin et al., 1986), yoghurt (Morgan et al., 1993) and acidic foods such as mayonnaise (Keene et al., 1994) were among the food vehicles incriminated in the EHEC outbreaks. The organism can affect all ages, requires a low inocula (50 viable cells) and can cause death (Neil, 1994). The virulence factor of EHEC is the production of shiga-like toxins (SLTs) or verotoxins (VTs) which have two types, the SLT-I and SLT-II (Konowalchuck et al., 1977 and 1978a & 1978b). The organism and its verotoxins are destroyed by adequate cooking or pasteurization (Verman and Evans, 1991).

In the last decade, efforts were conducted by several investigators on the detection of EHEC in dairy products. In USA, Padhye and Doyle (1991) and Chapman and Wright (1993) similarly isolated EHEC O157: H7 from 10% of the examined raw milk samples. In Germany, Montag (1994); Bockemuehl and Karch (1996) and Perlberg (1996) found that 2.63%, 4% and 3.95% of the examined raw milk samples, respectively, contained the pathogen. On the other hand, Knappstein et al. (1996) detected *E. coli* O157: H- in 9.2% and 59% of the examined heated and raw milk

cheeses, respectively. Abdel-Hakiem et al. (1998) isolated the pathogen of SLT-I and SLT-II producer from a yoghurt sample representing 0.81% of the examined dairy products. Literature on the behaviour of EHEC (O157:H7) in dairy products are nearly still lacking. However, Sharpe et al. (1995) found the organism survived well in refrigerated raw milk and dairy products, as well as low pH products. Reitsma and Henning (1996) reported that the pathogen survived in Cheddar cheese along the manufacturing course and remained viable for 102 days thereafter.

In Egypt, in some instances, milk produced by individual owners in small farms that lack of proper sanitation. In addition, some dairy products as soft cheeses, cream and butter are manufactured under local conditions from raw milk without addition of lactic acid starters or colourant. Such products, if consumed fresh or after being preserved in refrigerated conditions, represent a major source of foodborne illness with any of the virulent *E. coli* serotypes. Therefore, the present investigation is conducted to trace the pathway and fate of EHEC (O157:H7) when being inoculated in raw buffalo's milk, laboratory pasteurized milk, and the milk used in manufacturing of yoghurt and Damietta cheese.

## Material and Methods

### Preparation of EHEC culture

EHEC (O157:H7) strain of SLT-I and SLT-II producer was obtained from Dr. Aman, I. M, Faculty of Veterinary Medicine, Tanta University to be used in this investigation. The strain was subcultured overnight in trypticase soya broth at 30°C, centrifuged at 1200 rpm for 10 min at 4°C and the cells were washed with sterile saline 2-3 times with centrifugation. Finally, the gathered cells were suspended in sterile saline to be used for inoculation.

### Viability of EHEC in raw milk

Two liters of freshly drawn buffaloes' milk were obtained from the dairy farm of the Faculty of Veterinary Medicine, Suez Canal University. Before being inoculated, the milk was analyzed for naturally occurring *E. coli* by streaking 0.1 ml from the prepared tenth fold dilutions over sorbitol MacConkey agar (SMA) plates as described in A.P.H.A. (1992). The milk was then inoculated with the prepared cultures of the chosen organisms to obtain an initial inocula of ca  $10^8$  cells/ml. The inoculated milk was distributed aseptically after thorough mixing into two sterile stoppered-bottles. The first was placed in refrigerator ( $4\pm 1^\circ\text{C}$ ), while the second was left at room temperature ( $22\pm 2^\circ\text{C}$ ). Then, they were examined at 0 time and daily thereafter for EHEC counts, total bacterial counts (background microflora) and pH values.

### Viability of EHEC in pasteurized milk

The laboratory pasteurized buffaloes' milk ( $63^\circ\text{C}$  for 30 min followed by immediate cooling to  $<10^\circ\text{C}$  within 5 min) was inoculated with the prepared cultures of the chosen organisms to provide an initial inocula of ca  $10^8$  cells/ml. The inoculated milk was held in refrigerator ( $4\pm 1^\circ\text{C}$ ) and examined for EHEC counts, total bacterial counts (background microflora) and pH values during the 30 days storage period. Examination was performed daily during the first 5 days, every other day until the 15<sup>th</sup> day and every third day until the 24<sup>th</sup> day.

### **Viability of EHEC in yoghurt**

Yoghurt was prepared according to Lampert (1975) from previously heated (90°C) buffaloes' milk. After being cooled to 42°C, the milk was inoculated at a rate of ca 10<sup>8</sup> cells/ml with the prepared cultures of EHEC. Then the starter culture (fresh commercial product made from pasteurized milk having a minimum of 15 days shelf-life) was added at a rate of ca 0.2%. The inoculated milk was distributed in sterile, stoppered glass bottles (150 ml capacity) and incubated at 42°C until the formation of the desired curd. The prepared yoghurt was store in the refrigerator (4±1°C). Samples were taken before the addition of the starter and EHEC cultures, after their addition, after curd formation, daily until the 9<sup>th</sup> day and every other day until the end of the 15 days investigation period to be examined for EHEC counts and pH values.

### **Viability of EHEC in Damietta cheese**

Three lots of Damietta cheese were prepared from partially raw and heated (90°C) buffaloes' milk according to the traditional method of making such type of cheese in Egypt; the procedure described by Fahmi and Sharara (1950). The milks were inoculated with the test organism at a rate of ca 10<sup>8</sup> cfu/ml. Sodium chloride was added at concentrations of 1% (light salted "LS"), 3% (medium salted "MS") and 5% (high salted "HS"). Rennet extract was added according to the manufacturer's direction at a rate of 0.2%, and the formed curd was left to drain its whey for 24 h at room temperature. Each lot of prepared cheese, with its whey, was divided into two equal portions, one of which was left at room temperature (22±2°C) while the other was kept in refrigerator (4±1°C). Samples to be examined for EHEC and pH values were taken before inoculating the test organism, immediately after inoculation, after setting and curd formation, after draining the whey and periodically through the storage period of every type of the prepared cheeses.

### **Enumeration of EHEC and total bacterial count (TBC)**

A quantities of 0.1 ml of tenth-fold serial dilutions of milk and milk products were streaked on sorbitol MacConkey agar (SMA) and incubated at 32±1°C for 24 hours. When the counting procedure fail to find the characteristic colonies of EHEC from the dilutions as well as from the original sample, isolation trials using trypticase soya broth (TSB) overnight cultures were performed (A.P.H.A., 1992).

Total bacterial counts (TBC) of raw and pasteurized milk were determined according to A.P.H.A. (1992).

### **Measurement of pH**

The pH of the tested samples was measured using Jenway 3051 pH meter supplied with standard combination glass electrode. The apparatus was calibrated before each measure using standard buffer solutions pH 4.00 and pH 7.00 at 25°C.

## Results and Discussion

### Viability of EHEC in raw milk

Populations of the EHEC (O157:H7) test strain in the raw buffaloes' milk held at room temperature ( $22\pm 2^\circ\text{C}$ ) and in refrigerator ( $4\pm 1^\circ\text{C}$ ) are shown in Fig. 1. For milk left at room temperature (Fig. 1/A), it is very obvious that, EHEC O157:H7 populations remained unchanged during the first 5 days of incubation although the milk is curdled at the second day (pH 4.55). At the end of the holding period (10 days), the counts showed ca 5- $\log_{10}$  decrease. Such decrease can be assumed to be due to both competitive microbial growth, evidenced by the very high counts of background microflora achieving ca 14- $\log_{10}$  cfu/ml at the end of the 8<sup>th</sup> day, and the very low pH; reached 3.96 by the end of the holding period.

Concerning the refrigerated milk, it is easy to declare from Fig. 1/B that there was a somewhat regular slow reduction in the numbers of the inoculated organism along the term of incubation. However, the decline rate was greater during the first day, achieving ca 1.8- $\log_{10}$ . Such decrease in EHEC populations was accompanied by a corresponding regular increase in the background bacteria from 9.9- $\log_{10}$  cfu/ml at 0 time to 12.5- $\log_{10}$  cfu/ml by the end of the holding period. These findings lie in a very close agreement with those reported by Sharpe et al. (1995) and Heuvelink et al. (1998) upon testing the survivability of *E. coli* O157:H7 in raw cow's milk. Unfortunately, from such obtained results one can expect that raw milk, whatever its type, may play a significant role in disseminating *E. coli* O157:H7 among consumers. This is particularly true within the circumference of underdeveloped countries where the tradition of consuming milk at its raw state still common.

### Viability of EHEC in pasteurized milk

Populations of the *E. coli* O157:H7 test strain in the inoculated pasteurized buffaloes' milk held in refrigerator ( $4\pm 1^\circ\text{C}$ ) are shown in Fig. 2. It is very clear from the data assembled in the figure that, *E. coli* O157:H7 populations survived for the whole test period (30 days). They showed gradual regular decrease from the beginning (7.82- $\log_{10}$  cfu/ml) until the end of the holding period (1.4- $\log_{10}$  cfu/ml). The pH of the milk did not altered significantly through whole storage term as it was 6.6 at 0 h and achieved 6.28 at the 30<sup>th</sup> day. The background microflora increased at first achieving 9.32- $\log_{10}$  cfu/ml through the 3<sup>rd</sup> day after which they undergone a marked decrease along the rest of the investigation period. This decline in both *E. Coli* O157:H7 and total bacterial counts is, of course, due to the unfavourable low temperature of incubation. At such temperature the majority of microorganisms loss their ability to grow and only what is called "psychrotrophs" can survive. Indeed, in order to produce pasteurized milk free from the pathogen in concern, properly pasteurized product protected from any sort of post pasteurization contamination is an essential requirement.

### Viability of EHEC during preparation and storage of yoghurt

Careful inspection of the results shown in Fig. 3 reveals that *E. coli* O157:H7 populations have undergone considerable reduction (ca 2  $\log_{10}$ ) by the end of yoghurt preparation. Such reduction occurred during the 3 hours incubation at  $42^\circ\text{C}$ . Simultaneously, the pH of the product has decreased sharply from 6.16 upon adding the starter culture to 4.12 by the end of curd formation, explaining why did such decline in EHEC counts has taken place. There was continuous regular decrease in the numbers of the pathogen from day to day for upto the 9<sup>th</sup> day, after which 3 successive, every other day, isolation trials have failed to find the organism. This was certainly because it can no longer persist in the product. The pH of the yoghurt continued to de-

crease during its refrigerated storage, but to a much lesser extent than before. By the end of the investigation period, the pH of yoghurt has reached 3.96. These findings support what has been reported by Hudson et al. (1997), Abdel-Ghany and Hosny (1998) and El-Hawary and Aman (1998). A faster disappearance of *E. coli* O157:H7, occurring just after the curd formation of yoghurt, was recorded by Dineen et al. (1998). Such difference could be attributed to the smaller initial inoculum ( $10^5$  cfu/ml milk) added upon processing the yoghurt and/or variability in the virulence among the tested strains. However, the same authors established that *E. coli* O157:H7 was recovered at  $<10$  cfu/g at 12 days from commercial yoghurt (pH 4.0) inoculated by the same organism at a rate of  $10^3$  cfu/g. So, they concluded the presence of *E. coli* O157:H7 cells in yoghurt is more likely to reflect post processing contamination than survival of the organism through the yoghurt fermentation process. Indeed, the obtained findings suggest that both ways can lead to its presence in yoghurt during the few days of its refrigerated storage following processing. The persistence of the pathogen in yoghurt at low pH for such period confirmed the implication of yoghurt in an outbreak of HC in London as reported by Morgan et al. (1993).

### Viability of EHEC during manufacturing and storage of Damiette cheese

With regard to the cheeses stored at room temperature assembled in Fig. 4/A, one can recognize that *E. coli* O157:H7 is considerably inhibited as the salt content of the cheese increased. In the LS cheese, populations of the inoculated pathogen remained unchanged for as long as 28 days storage. The organism appeared as if unaffected by the lowered pH (3.59) of the cheese at that time. Populations of *E. coli* O157:H7 showed a marked decrease during the rest of the storage term from  $7.08\text{-log}_{10}$  cfu/g at the 28<sup>th</sup> day to  $2.76\text{-log}_{10}$  cfu/g at the 70<sup>th</sup> day. In MS cheese, the organism behaved more or less similarly as in LS one. Concerning HS cheese, the effect of the high salt content on the test organism was very pronounced from the first moment. It was reflected by a ca  $3.5\text{-log}_{10}$  cfu/g decrease in comparison with the former ones (LS & MS) during course of manufacturing and storage. The test organism could not survive until the end of its storage term. Actually, we have to point out here that there were a marked fungal growth (unpresented data) in all the 3 types during the last stages of storage (40<sup>th</sup> -70<sup>th</sup> day). Perhaps, this phenomenon (competitive growth) was the reason of the higher survivability of *E. coli* O157:H7 in LS and MS cheeses than in HS one, because it was more pronounced in the former than in the later two cheeses.

Concerning the refrigerated cheeses (Fig. 1/B), the organism populations in the LS cheese showed a regular gradual slight increase during the first 4 weeks after which they started to decrease. There were  $8.5\text{-log}_{10}$  cfu/g at the beginning of the refrigerated storage,  $9.7\text{-log}_{10}$  cfu/g at the 28<sup>th</sup> day and reached to  $7.1\text{-log}_{10}$  cfu/g by the end of the storage term. In correspondance, the pH has undergone a steady gradual decrease from ca 5.5 at the first day to ca 4.5 by the end of the storage term. A somewhat lower EHEC counts and higher pH values were registered through the whole refrigerated storage term of the MS type of cheese. Therefore, the inhibitory effect of the higher salt concentration upon EHEC in the MS cheese overcame that of the lower pH values in the LS one. In the HS cheese, EHEC populations undergone a significant decrease through the manufacturing course, but remained a more or less unchanged during the refrigerated storage term. In comparison with the other 2 cheese types, HS cheese appeared to be the most inhibitory one to the tested strain, although its pH was relatively higher. In general, such obtained results revealed that the higher the salt content in the cheese, the higher the degree of inhibition of EHEC regardless of the product pH. These findings to have some degrees of similarity with

those reported by Reitsma and Henning (1996) and Ramsaran et al. (1998) upon their tested cheese varieties. However, Glass et al. (1998) recorded a comparably lower *E. coli* O157:H7 in the inoculated processed cheese slices. The obtained results also revealed that the storage temperature had a marked effect upon the survival rate of the tested strain. If the temperature is high, it favours the growth of lactic acid producing bacteria resulting in high death rate of the organism.

In conclusion, these findings gave us a clear idea about the high possibility with which dairy products contaminated by such powerful pathogen be hazardous to consumers due to its longevity therein. The most important factor in the prevention of gastroenteritis in human by pathogenic *E. coli* is to prevent contamination of food and water, directly or indirectly, by faecal matters. This can be achieved by developing effective sanitation in water supplies, and treatment and disposal of sewage. Another factor to be considered is the prevention of contamination of foods due to poor personal hygiene by people who are shedding the pathogen. Here, in Egypt, we are in great need to stop the manufacturing of dairy products from raw milk or inadequately heat treated one. Finally, we have to recognize that if the pathogen is present in very small initial numbers in a food, temperature abuse can facilitate multiplication of cells to high levels necessary for disease symptoms. Thus foods, including, of course, milk and various types of dairy products should be refrigerated or eaten quickly (Kornacki and Marth, 1982 and Garvani, 1987).

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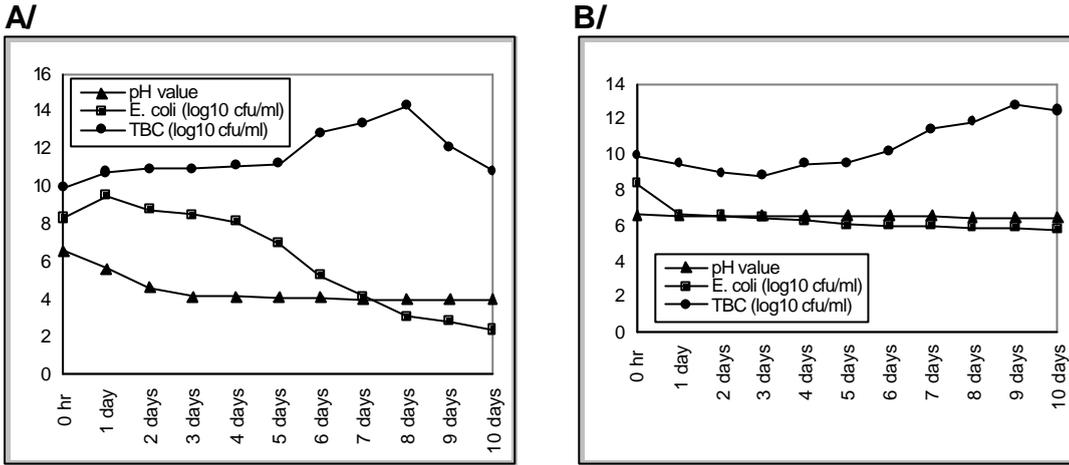


Fig.1 Survival period of EHEC in raw buffalo's milk held at: A/ 22±2°C (room temperature)---B/ 4±1°C (refrigerator)

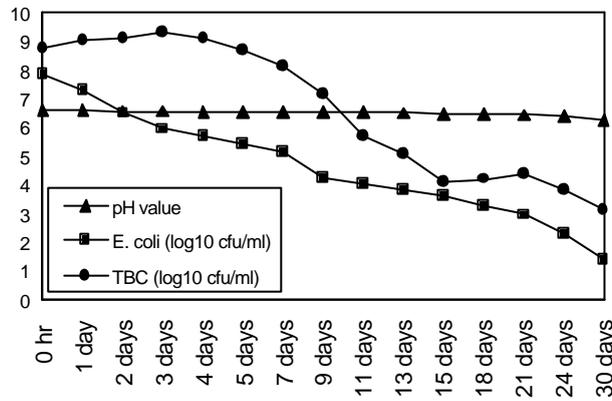


Fig.2 Survival period of EHEC in pasteurized milk held at (4±1°C).

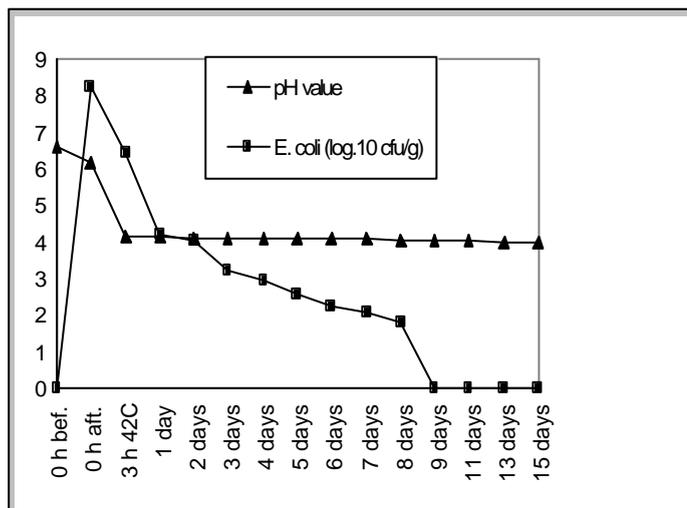


Fig.3 Survival period of EHEC during preparation and storage of yoghurt  
 0 h bef.= before inoculation of EHEC and starter  
 0 h aft.= after inoculation of EHEC and starter  
 3 h 42C= after 3 hours incubation at 42°C

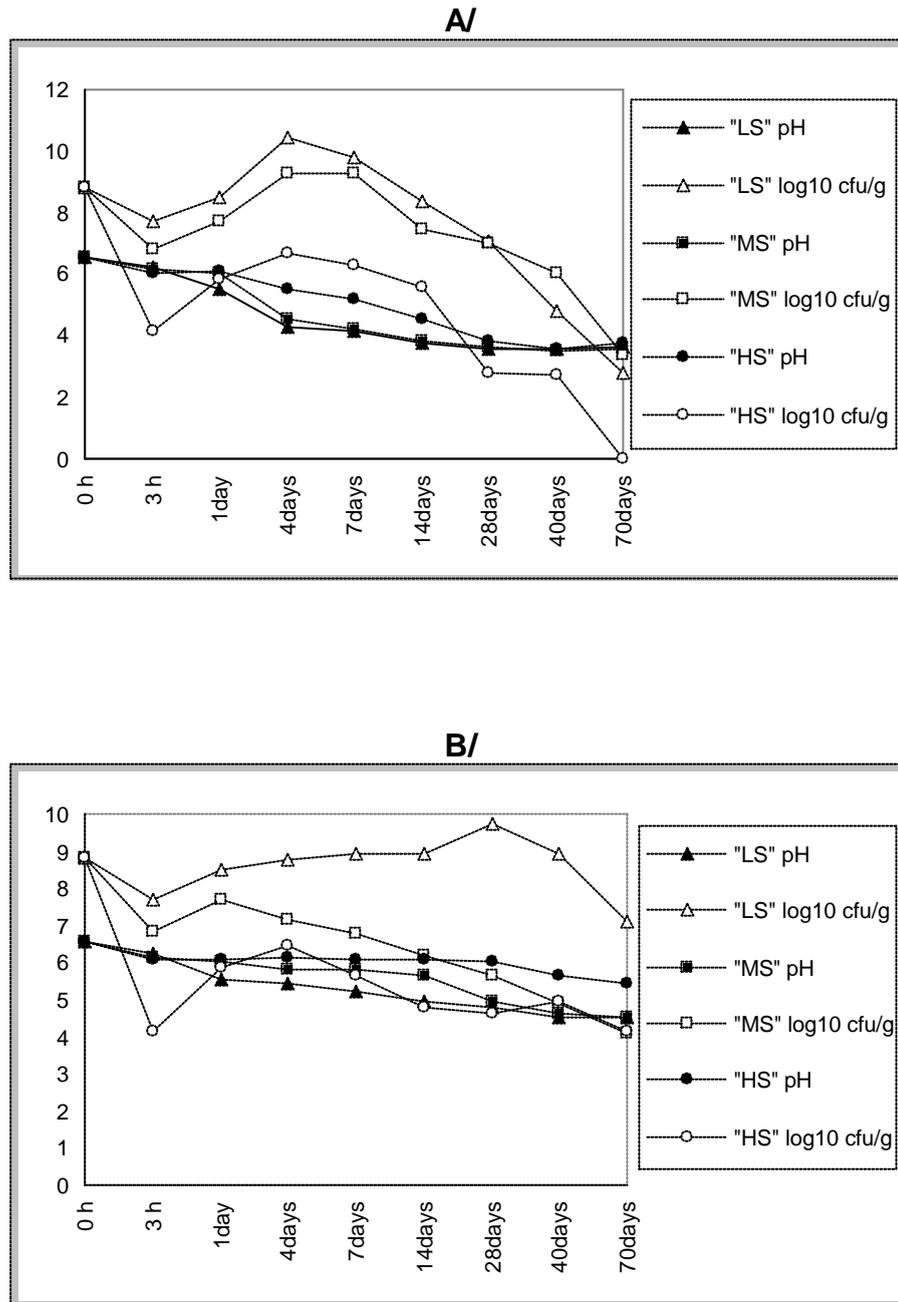


Fig.4 Survival period of EHEC during preparation and storage of Damietta cheese at:  
 A/ 22±2°C (room temperature)---B/ 4±1°C (refrigerator)

0 h = from the milk just after adding the prepared culture

3 h = from the formed curd 3 hours later at 32°C

1 day = from the prepared cheese after draining the whey 24 hours later at room temperature.

## Studies on the *Pseudomonas aeruginosa* isolated from fleece rot in sheep suffering from dermatitis in northern & middle Jordan

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### Abstract

A total of 162 sheep fleece samples ( 7% ) were bacteriologically examined. Seventy nine sheep of them showed clinical signs in which exudation and abcessation were recorded in 21 (13%) sheep, while fleece coloration was observed in 18 (11 %) and mixed clinical signs in 7 (4 %). The rest 83 (51 %) sheep showed no obvious clinical signs. Seventeen *Pseudomonas aeruginosa* isolates were cumulated. The isolates were identified biochemically and their susceptibility toward 16 commonly used antibiotics was determined. The resistance toward amikacin, ciprofloxacin and the norfloxacin was determined in 11.7%, 23.4 % and 29.4%, respectively while the knanmycin, streptomycin, tetracycline, amoxycillin, erythromycin and the co-trimoxazol were ineffective against more than 90% of the *P. aeruginosa* isolates. Intermediate resistance against each of the norfloxacin, ciprofloxacin, enrofloxacin, kanamycin, streptomycin, tetracyclin, amocycillin, erythromycin, ampicillin, neomycin, doxicyclin, nalidixic acid, amikacin, nitrofuantoin was recorded among 6, 7, 5, 5, 2, 1, 1, 1, 2, 3, 7, 1 and 2 of the examined *P. aeruginosa* isolates.

Fourteen (82%) isolates were recorded as serum resistant and their count after 1-3h incubation in the sheep and calf sera, increased by 2-2.9 and 2.5-3.5 logs, respectively.

### Introduction

Sheep fleece rot is an exudative bacterial dermatitis associated and influenced by the low hygienic raising conditions such as prolonged wetting of the skin (2, 8). *P. aeruginosa* seems to be the main causative organism of fleece rot and it was concluded that it contributes in the disease complex. The importance of *P. aeruginosa* which was associated with increased severity of fleece rot and subsequent flystrike can not be underestimated and warrants consideration for inclusion it in fleece rot diagnosis and control trials such as vaccination ( 8 ). Experimentally, the sheep which were inoculated cutaneously with *P. aeruginosa* developed rapidly a green coloration while the animals which were kept dry, showed no signs of dermatitis ( 2). This coloration was associated with an outpouring of serous exudates in the fleece rot lesion and with the formation of microabscesses (2).

On the other side, although the *P. aeruginosa* was evaluated as possible cause, in part, to the disease complex, its role and severity in the fleece rot should not be underestimated ( 8). It should also be taken in consideration in the diagnosis of the fleece rot as well as in its control trials e.g. vaccination ( 8).

Serologically, the sheep which were wetted and inoculated with *P. aeruginosa*, unlike the dry animals, showed a serologic reactivity (2). Such seroreactivity was against the outer rather than the inner membranous protein of the bacterium (2).

*P. aeruginosa* is among the bacteria, which show a remarkable resistance toward many antibiotics (1, 5). Clinically, significant *P. aeruginosa* strains were found resistant to eight relatively new antibiotics (1). Such a resistance ranged from 9.1% to 31.9% toward the individual antibiotics (1). Combination of two or more antibiotics is likely to be needed to assign the antibiotic treatment protocol. For example, combinations of the gentamicin, lincomycin, spectinomycin and tylosin or the combination of penicillin, streptomycin, lincomycin, spectinomycin and minocycline were tried but yet *P. aeruginosa* recovered by *in-vitro* testing of such combination (5, 6).

Serum-resistance which counteracts the bactericidal effect of the complement system is an important factor in the pathogenicity of *P. aeruginosa* (12). Thirty seven percent of clinical isolates were found to be serum resistant (13). However, such a resistance was attributed to certain serotypes (12) where the serotyping, along with the isolation site, antibiotic resistance, and beta-lactamase production were approached to determine the profiles of *P. aeruginosa* from clinical isolates (7, 14, 12).

Since, in Jordan, no information is available about this affection, this study aims to determine the prevalence of fleece rot dermatitis among sheep herds in the northern and middle sectors of Jordan, to isolate the bacterial causation with special reference to the *Ps. aeruginosa* and to determine the antibiotic sensitivity and the serum resistance patterns of the isolates

## Materials and Methods

A total of 162 wool samples were aseptically collected from 32 sheep herds (2273 heads). Collection of the samples was reconsidered, as possible, to be from animals showing abnormal skin problems especially from those having skin/wool discoloration or associated with an exudates and abscesses.

The samples were processed, promptly. They were cultivated on different enriching / differential media, namely: *Pseudomonas* selective agar, Sheep Blood Agar, MacConkey Agar, Tryptic Soy Agar and Tryptic Soy Broth. All of the media were from OXOID. The media were incubated at 37°C for 24-48 h under aerobic conditions.

A total of 17 (10.5%) isolates showing the general characteristics of the *Pseudomonas aeruginosa*, specially the production of greenish/bluish pigmentation and/or the characteristic fruity odor, were cumulated.

For confirmatory diagnosis and for characterization the isolates, different biochemical reactions were determined, namely: oxidase production, growth at low (5°C) and high (42°C) temperature, citrate utilization, OF (glucose fermentation), sugar fermentation (fructose, mannitol and xylose), nitrate reduction, gelatin liquefaction, urease production, tween hydrolysis and the motility reactions according to Koneman (9) and Cowan & Steel (4). Sensitivity to antibiotics was conducted by determination of the minimum inhibitory concentration in solid medium according to the guidelines of the National Committee for Clinical Laboratory Standards (11).

For determination of their serum resistance, blood of 6 healthy sheep as well as of 3 healthy young calves was collected and the serum of each species was pooled. To assay (15) the serum resistance of the *P. aeruginosa* isolates, 80% of each untreated and heat treated (56°C/30 min) serum was used. The serum heating aims to inactivating the complement bactericidal components. An 18h old tryptic soy broth culture of each isolate was subcultured into a tryptic soy broth and was grown to the mid-log

phase. Cells (approximately  $3 \times 10^7$ / ml) were added directly to treated and untreated sera and incubated at 37°C for certain intervals. After elapsing of 0, 1, 2 and 3 hours, the viable bacterial count was determined, in triplicate, by ten folds dilution (15).

## Results

A total of 162 samples (7%) were examined (Table 1) from which, 17 *P. aeruginosa* isolates were cumulated. The samples were collected almost equally from both sexes but the majority (127 samples) were from elder sheep (1-2 years old). Clinical signs could be observed in 79 sheep. The exudation and abcessation were recorded in 21 (13%), the coloration in 18 (11 %) and mixed clinical findings were recorded in 7 (4 %). The majority, 83 (51 %) of the examined sheep showed no obvious indicative clinical signs.

The antibiotic resistance patterns of the 17 *P. aeruginosa* isolates against 16 antibiotics are displayed in Table 2. The recent antibiotics like the amikacin, ciprofloxacin and the norfloxacin were not fully effective where resistance against them was determined in 11.7%, 23.4 % and 29.4%, respectively. On the other side, the antibiotics of old generation like the knanmycin, streptomycin, tetracycline, amoxycillin, erythromycin and the co-trimoxazol which were ineffective against more than 90% of the tested *P.aeruginpsa* examined strains. However, intermediate resistance against each of the norfloxacin, ciprofloxacin, enrofloxacin, kanamycin, streptomycin, tetracyclin, amocycillin, erythromycin, ampicillin, neomycin, doxicyclin, nalidixic acid, amikacin, nitrofuantoin was recorded among 6, 7, 5, 5, 2, 1, 1, 1, 2, 3, 7, 1 and 2 of the examined *P. aeruginosa* isolates.

Figures 1 and 2, show the serum resistance patterns of the 17 *P. aeruginosa* strains. By using the heated (inactivated) sheep serum (Fig. 1), the count of all 17 isolates increased by 2 - 3.1 logs while the count only of 3 isolates incubated in the untreated serum decreased by 0.7 - 1.3 logs. The other 14 (82%) strains were recorded as resistant and their count increased in 2-2.9 logs. By using the calf serum, almost the same pattern among the 17 isolates was recorded. However, the same previously notified 14 (82%) resistant strains showed, relatively, higher count which was ranging from 2.5-3.5 logs (Fig. 2) while the count of sensitive ones decreased in 1-1.8 logs.

## Discussion

Wool production is a strategic target of sheep raising. Certain factors may predispose the skin affection which results to dermatitis and consequently to lowering of the fleece quality (2, 8). In this study, about 49% of the examined sheep showed various skin/fleece denaturations (table 1) from which about 13% were having clinical signs in form of exuadation and abcessation. The incidence of fleece rot increases in humid environment and/or in wet skin (2, 8) especially among the unvaccinated (8) herds. In this study, the *P. aeruginosa* was isolated in 10.5% from the examined samples which indicates its remarkable role (2) in sheep dermatitis and subsequently in the development of fleece rot in Jordan. This is strongly predicted, especially that 13 out of the 17 (82%) isolates were cumulated in the period between December-April months which are wet and/or humid months in Jordan (2, 8). Indeed, in March-April months in which the atmospheric temperature starts to increase, 6 (35%) isolates were cumulated and the role of flies in spreading of the infection among herds (8) can not be excluded.

In Jordan, lack of vaccination attempts (8) for competing such affections, may add some other factor in this sheep health problem. On the other hand, unlike the sex, the age can be counted as another predisposing factor since the *P. aeruginosa* was mostly isolated from the B and C age groups i.e. elder sheep (table 1).

*P. aeruginosa* is well known in its resistance against a wide spectrum of antibiotics. In this study, the antibiotic susceptibility of the isolated *P. aeruginosa* strains was tested toward 16 different antibiotics which were comprising recent as well as antibiotics of old generations (Table 2). In the UK, about 18.5% of the *P. aeruginosa* were resistant, or had reduced susceptibility, to some recent antibiotics (3). Although the new antibiotics used in this study, namely: amikacin, ciprofloxacin and the norfloxacin were effective in about 82%, 77% and 71%, respectively and a remarkable number of the susceptible isolates showed, however, an intermediate susceptibility. These results indicate the diminishing of efficacy of these antibiotics against the *P. aeruginosa*. Such findings, indeed, ring the bell about the merging and the developing of some resistance against these new antibiotics, especially that the antibiotic misuse is problematic to the health authorities/enterprises in the world including this country. Synergistic combination of two or more antibiotics is commonly, *in-vitro*, investigated (10). The ciprofloxacin combined with the imipenem did not result to improving the effect of the ciprofloxacin on the *Pseudomonas sp.* while the addition of a third rifampicin antibiotic, results to remarkable synergistic effect (10). In this study, some isolates displayed a high (< 90%) resistance against the majority of the old antibiotics. However, the rest 10% of isolates, which were recorded as susceptible ones, were, indeed, having an intermediate susceptibility. Such findings were obviously, recorded toward the tetracycline, amoxicillin, erythromycin and ampicillin (Table 2).

The bactericidal effect of the serum is mainly referred to the complement effect. In this study, serum resistance of the isolated *P. aeruginosa* was determined against sera of two animal species, namely: the sheep from which the *P. aeruginosa* was isolated and the calf as a foreign species. Although the 14 serum resistant strains showed the same resistance patterns toward the sera of both sources, their count in the calf serum was determined, relatively, with higher logs (2.5-3.5 logs) than that in the sheep serum (2.5 - 2.9 logs). On the other side, the viable count of each of the 3 (18%) serum sensitive isolates was decreased and was determined in lower 1 - 1.8 logs when they were exposed to the untreated calf serum.

This is the first study deals with sheep dermatitis/fleece rot problem in Jordan. The obtained results indicate the importance of further investigation to explore the different circumstances affecting such sheep infection especially that sheep migration between Jordan and the neighbouring countries is not uncommon and does undergone deficient control / quarantine measures.

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## Histometric Studies of the Equine Hoof Wall in Normal and Laminitic Horse

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### Summary

The study was carried on 10 clinically normal horses and 10 horses subjected to experimental laminitis. Histometric examination of hoof specimens was done, after staining, using micrometer eyepiece. The results showed a significant ( $p < 0.05$ ) decrease in the number of horny tubules /  $\text{mm}^2$ , the maximum transverse diameter of the tubule, the thickness of the cortex, the quotient value of the thickness of the cortex / maximum transverse diameter of the tubule in horses affected by laminitis. Whereas, the maximum transverse diameter of the medulla, the quotient value of maximum transverse diameter of the medulla / thickness of the cortex, the quotient value of maximum transverse diameter of the medulla / maximum transverse diameter of the tubule, total surface area of the medulla, the quotient value of medullary surface area / tubular surface area were significantly ( $p < 0.05$ ) increased in laminitis. It was concluded that the histometric changes in the microstructure of the tubular and intertubular horn play an important role in the production of poor quality hoof horn during laminitis.

### Introduction

The hoof wall is composed of three layers: stratum externum, stratum medium and stratum lamellatum (Dellman, 1981). The stratum medium forming the bulk of the wall and consists of tubular and intertubular horn. The horny tubule consists of cortex and medulla. The cortex has three zones; the inner, middle and outer zones containing keratinized cells oriented around the medulla in a fairly tight coils.

The medulla contains loose elements (Wilkens, 1963; Stump, 1967; Steven, 1981 Dirks, 1985 and Christopher, 1995)

Equine laminitis is an inflammation of the dermo-epidermal junction especially in the dorsal hoof wall (Wintzer, 1982 and Stashak, 1987). Histopathological studies in horses and cattle affected by laminitis revealed disturbances in the epidermal keratinization process (Obel, 1948; Roberts et al, 1980 and Ekfalck et al, 1988).

Histopathological changes in the stratum medium during experimental laminitis in the horse showed cylindrical, oval or atrophied horny tubules associated with multiple cyst formation. The intertubular layers and the onychogenic fibers appeared swollen and fragmented (Mostfa, 1986). The developing horny cells are remarkably small and their intercellular space is widened (Marks and Budras, 1987).

Meyer (1985) concluded that the horn quality of the hoof is influenced by its microstructure which in turn can be determined by variable histometric parameters. The quality of the hoof horn depend on the number of tubules, the boundaries of tubules with the intertubular horn and the percentage of tubules to the intertubular horn (Tscherne, 1910; Dietz et al, 1971; Fuchs, 1976 and Kastner, 1976).

There is little literature concerning the histometric changes in tubular and inter-tubular horn during laminitis in horse. The aim of the present work was to describe the changes in the histometric parameters of the microstructure of the hoof wall in normal and in horses affected by laminitis to gain a basis for diagnosing the frequent pathological changes of the equine hoof.

## Materials and Methods

Histometric examination of the normal hoof was done on specimens collected from euthanized 10 horses. The hoof was obtained and splitted longitudinally at the middle of the toe by means of a saw. A specimen 1 cm x 1 cm including the structures of the whole thickness of the hoof was obtained from the upper, middle and lower parts of the hoof wall.

Laminitis was experimentally induced in horses by overfeeding of concentrated carbohydrate diet which consisted of 17 gm/kg b.w. of corn starch and 1.2 gm/kg of very fine saw dust (Mostafa, 1987). Hoof specimens were taken, at different times (24 and 48 hr., 6, 10, 20, 30, 40 and 75 days). The samples were preserved in 10% formal-saline solution and sectioned using freezing microtome at - 30 C into thin sections about 5  $\mu$ m. Staining was done with haematoxyline and Eosin stain, periodic acid schiff reaction and Van Giesson stain (Carleton, et al, 1967).

The hoof sections were examined for the following histometric parameters: counting the number of horny tubules /  $\text{mm}^2$  according to Geyer (1980), Hartel (1985) and El-Ghoul (1991); measurement of the maximum transverse diameter of the horny tubules and its medulla (Hofstetter, 1985); calculation of the thickness of the cortex (Empel et al, 1982); calculation of the maximum transverse diameter of the medulla / thickness of the cortex (Dietz, 1976); calculation of the maximum transverse diameter of the medulla / maximum transverse diameter of the tubule (Hofstetter, 1985); calculation of the thickness of the cortex / maximum transverse diameter of the tubule (Empel et al, 1981); measurement of the total surface area of the medullary and horny tubules; calculation of the medullary surface area / tubular surface area (Hofstetter, 1985) and calculation of the surface density (Hartel, 1985).

Statistical analysis of the data were done by *t*- test and ANOVA using SPSS (Statistical Product & Service Solutions) (Kuehl, R., 1994). All data were presented as mean  $\pm$  standard error, and  $p < 0.05$  was considered significant.

## Results

The results of the histometric examination revealed that, the average number of horny tubules, the maximum transverse diameter of the tubule, the thickness of the cortex and the ratio of the cortex thickness / tubular diameter in laminitis were significantly lower ( $p < 0.05$ ) than that of the clinically healthy horses (table 1 and figures 1, 2 and 3).

The maximum transverse diameter of the medulla, the ratio of the medullary diameter / cortex thickness, medullary diameter / tubular diameter, medullary surface area / tubular surface area and the total surface area of the medulla were significantly higher ( $p < 0.05$ ) in laminitis than that of the clinically healthy horse (table 1 and figures 4, 5 and 6).

Insignificant differences were found in the total surface area of the tubule and the surface density between normal and laminitic horses (table 1).

**Table 1: Histometric parameters in normal and laminitic horse.**

Histometric parameters	Normal hoofs	Laminitic hoofs
	mean $\pm$ SE	mean $\pm$ SE
Number of horny tubules /mm <sup>2</sup>	11.634 $\pm$ 0.196	10.477 $\pm$ 0.091**
Maximum transverse diameter of the medulla ( $\mu$ m)	15.241 $\pm$ 0.819	18.581 $\pm$ 0.989**
Maximum transverse diameter of the tubule ( $\mu$ m)	67.517 $\pm$ 4.351	56.706 $\pm$ 1.796**
Thickness of the cortex ( $\mu$ m)	25.732 $\pm$ 2.226	18.642 $\pm$ 0.952**
Maximum transverse diameter of the medulla / thickness of the cortex	0.806 $\pm$ 0.127	2.759 $\pm$ 0.550**
Maximum transverse diameter of the medulla / maximum transverse diameter of the tubule	0.261 $\pm$ 0.024	0.363 $\pm$ 0.021**
Thickness of the cortex / maximum transverse diameter of the tubule	0.368 $\pm$ 0.012	0.318 $\pm$ 0.011**
Total surface area of the medulla	198.255 $\pm$ 25.930	533.622 $\pm$ 86.719**
Total surface area of the tubule	3591.503 $\pm$ 407.41	3483.866 $\pm$ 212.44
Medullary surface area / tubular surface area	0.078 $\pm$ 0.014	0.179 $\pm$ 0.023**
Surface density	39076.6 $\pm$ 5609.2	35193.7 $\pm$ 2145.1

The histometric parameters in the hoof wall at different times from the onset of laminitis revealed a significant decrease ( $p < 0.05$ ) in the number of horny tubules, thickness of the cortex and surface density which starting at 2 and 6 days after appearance of signs of laminitis (table 2 and figures 7,8 and 9). The maximum transverse diameter of the medulla, total surface area of the medulla and the tubule, the ratio of medullary diameter / tubular diameter, medullary diameter / cortex thickness and medullary surface area / tubular surface area were significantly ( $p < 0.05$ ) increased at 2 and 6 days after appearance of signs of laminitis. Inconstant significant changes were observed in the histometric parameters from 10 to 75 days (table 2 and figures 10 and 11).

## Discussion

Poor hoof horn quality generally manifests clinically as hoof affections (Eustace, 1994). The horn quality of the hoof is influenced by its microstructure which can be judged by histometric examination (Meyer, 1985). Many authors established certain parameters for evaluation of the horn quality (Dietz, 1976; Hofstetter, 1985 and El-Ghoul, 1991).

Histometric studies of normal equine hoof in this study revealed that the number of horny tubules is 11.634 tubules / mm<sup>2</sup>. Whereas Tscherne (1910) counted 5.0 tubules / mm<sup>2</sup> and Rossner (1940) found 9.8 tubules / mm<sup>2</sup> in the normal hoof wall. This may be attributed to the breed differences which influence the number of tubules as mentioned by Sedlacek (1933) who stated that the number of horny tubules is higher in hot - blooded horses than in cold - blooded one.

During this study, histometric evaluation of the hoof microstructure showed that the number of horny tubules / mm<sup>2</sup>, the maximum transverse diameter of the tubule, the thickness of the cortex, the quotient value of the thickness of the cortex / maximum transverse diameter of the tubule in laminitis were significantly ( $p < 0.01$ ) lower than normal horse.







The number of the horny tubules determines the hardness of the hoof. The higher the number of tubules the harder the hoof horn. A horn with low number of tubules, means more intertubular surface (Dietz, 1976 and Empel et al, 1982). The increase in the thickness of the cortex and the quotient value of the thickness of the cortex / maximum transverse diameter of the tubule means increase in hoof horn hardness. That is because the tubular cortex is formed of cells of high quality which surround the medulla and give the tubule the first rate stabilization character (Geyer, 1980). The maximum transverse diameter of the tubule determines the hardness of the hoof, the wider the diameter, the softer is the hoof horn (Distal et al, 1981).

Consequently our findings showed poor horn quality of the hoof during experimental laminitis. Defects in the hoof horn reduce the functional integrity and are a major cause of reduced performance of the horse (Kempson, 1990). Therefore, decrease in the number of the horny tubules and the thickness of the cortex and increase in the tubular diameter reduced the quality of the hoof horn during laminitis.

The results of the maximum transverse diameter of the medulla, the quotient value of maximum transverse diameter of the medulla / thickness of the cortex, the quotient value of maximum transverse diameter of the medulla / maximum transverse diameter of the tubule, total surface area of the medulla, the quotient value of medullary surface area / tubular surface area in laminitis were significantly higher ( $p < 0.01$ ) than the normal horse.

Distal et al (1981), Hofstetter (1985) and Zincker (1995) concluded that the increase in the maximum transverse diameter of the medulla, the total surface area of the medulla and tubule and their ratios indicates the increase in hoof horn softness. That is because the medulla is formed from decayed cells of poor quality.

The obtained results revealed a significant decrease in the number of horny tubules, surface density and thickness of the cortex, meanwhile a significant increase in the diameter and surface area of the medulla starting at 2 and 6 days after appearance of signs of laminitis. The results of the histometric parameters indicated that, the changes in the hoof microstructure require a time for appearance than the changes in the microcirculation of the hoof corium which occur directly following induction of laminitis (Nilsson, 1963).

There is association between the hoof affected with laminitis and poor hoof horn quality. As weak, poor quality hoof horn appears to lose its natural water - proofing properties, more prone to environmental influences, cannot protect against concussion and generally manifests clinically as hoof affections (Kempson, 1990; Eustace, 1994 and Zincker, 1995).

The findings of histometric parameters determined in this study indicated that, laminitis leads to formation of poor quality horn which make the hoof more susceptible to affections as mentioned by Kempson (1990). Furthermore, these results potentiate the hypothesis that laminitis is associated with changes in the epidermal parts of the hoof (Obel, 1948).

In conclusion histometric studies of the microstructure of the hoof during laminitis are accompanied with changes in the quality of horn material. The decreased in the number of the horny tubules and the thickness of the cortex coincide with the increase in diameter and surface area of the medulla and tubules will produce poor hoof horn quality.

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## Relationship between claw disorders and metabolic disturbances in dairy cattle<sup>1</sup>

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### Summary

The study was performed on a total number of 143 dairy cows affected by both claw disorders and metabolic disturbances. It was found that, in cows affected by claw disorders associated with alkalosis, the average proportion of segmented neutrophils, CK activity, GLDH activity and TP were significantly higher. In cows associated with primary acetonaemia, the proportion of eosinophils and the CK activity were significantly higher. In hypocalcemia the haematocrit value and Ca level was significantly lower, whereas the total leukocytic count, segmented neutrophils, and urea were significantly higher than normal. In hypophosphatemia the average P was significantly lower, whereas the average CK and bilirubin were significantly higher. In cows associated with hypomagnesemia the proportion of segmented neutrophils, CK activity, GLDH, TP and bilirubin were significantly higher, whereas the average Mg was significantly lower. In cows affected by fat cow syndrome the proportion of segmented neutrophils, GLDH activity and TP value was higher than normal. It was concluded that, the metabolic and microcirculatory changes associated with ruminal acidosis, acetonaemia, fatty liver, hypocalcemia, hypophosphatemia and hypomagnesemia leading to ischemic necrosis and degeneration of the horn producing structures and destruction of the connection between claw horn and corium predisposing to claw affections.

### Introduction

The horn quality of the claws appear to be affected very much by the animal's metabolism. Metabolic changes may predispose to the occurrence of chronic necrotic pododermatitis (Greenough, 1962).

The trigger mechanism is thought to be in the digestive tract. Absorption of toxic fermentation products into the circulation brings the action to the burdened pododerm. Damage of this tissue manifests itself in a latter stage in the claw sole (Peterse, 1987).

Laminitis arising from a systemic disorder due to a wide spectrum of probably largely interdependent aetiological factors. These varies from systemic influences such as metabolic and digestive disorders, calving or severe inflammatory processes (e.g. endometritis or mastitis) to localized influences in the claw. However, all have something in common; in a first phase, predominantly vasoactive substances which have been released into the circulatory system, may trigger pathological mechanisms which ultimately cause degenerative changes in the epidermal-dermal junction of the claw (Baggott, D.G., 1982 and Ossent, P. and Lisher, C., 1994).

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The following three factors were suggested to be important in triggering the changes in the claws: (a) endotoxin released from inflammatory foci and endotoxaemia, (b) lactic acid in relation to ruminal acidosis and (c) histamine, released in allergic reactions are absorbed from the gut (Bossman, 1990 and Vermunt, 1994).

The aim of the present study is to search in the causes of claw affections combined with metabolic disturbances in dairy cows through examination of total blood picture, biochemical blood parameters, acid - base balance, blood clotting profile, urine and ruminal fluid.

## Material and methods

The study was performed on a total number of 143 cows affected by both claw disorders and metabolic disturbances. From these cows 110 one were examined for total blood picture, biochemical blood parameters, urine and ruminal fluid. Another 21 cows examined for blood clotting profile and another 12 cows for acid-base balance. All cows were examined for claw status.

### Claw examination:

To determine the site of lesion, the claw was examined routinely by cleaning, manual palpation, pressure test, percussion, paring the horn and probing (Rosenberger et al, 1979). Dignosis of claw affections was based on the clinical signs and symptoms as defined in literature particularly the observations of Weaver et al (1981).

### Blood examination:

Blood samples were taken in two tubes one containing EDTA for whole blood collection, the other being for serum.

*Total blood picture:* haemoglobin, haematocrit, erythrocytic and total leukocytic count were determined in an automatic microprocessor - based haematology analyzer. The proportion of eosinophils, basophils, unsegmented, segmented, juvenile and immature neutrophils, lymphocytes and monocytes were calculated manually by counting 100 leukocytic cells in zigzag manner in different microscopic fields and calculate the percentage of each type.

*Blood biochemical parameters:* Serum Ca and Mg were determined in an atomic absorption spectrophotometer. Serum sodium and potassium were determined, quantitatively, in an Electrolyte Analyzer. Serum inorganic phosphorus, aspartate aminotransferase, creatin kinase, glutamat-dehydrogenase, gamma glutamyl transferase, total protein, bilirubin and urea values were determined in an auto - analyzer.

*Blood clotting profile:* Two blood samples were taken , one containing sodium citrate and the other whole blood. The blood platelets was counted in an automatic microprocessor-based haematology analyzer. The Coagulometer was used for determination of recalcification time, partial plasma thromboplastin time (PTT), plasma thromboplastin time (TPT), plasma thrombin time (TT) and fibrinogen. Recalcification time was determined chemically (200 µl citrated blood (1 : 9), 1 minute prewarming and with 200 µl 0,025 molar Calcium chloride mixing ). The Thromboplastogram reaction time (TEGr), clot formation time (TEGkt) and maximum amplitude (TEGma) were determined in Thromboplastograph-D.

*Acid - base balance:* Blood samples were taken on heparin and transfered in ice. Acid -base balance parameters were determined in an automatic blood gas analyzer. The examined parameters are: hydrogen ion concentration (pH), carbon

dioxide tension ( $p\text{CO}_2$ ), oxygen tension ( $p\text{O}_2$ ) concentration of hydrogen carbonate ( $\text{HCO}_3^-$ ) and actual base excess (ABE).

Urine examination:

Urine was examined for colour, specific gravity, pH, protein, ketone bodies, glucose, bile pigments and haemoglobin and red blood cells (Combur test). The judgment of the examined parameters depends on the colour of the reaction (Rosenberger et al, 1979).

Ruminal fluid examination:

The ruminal fluid was examined directly for colour, odour, viscosity, pH, sedimentation and floatation activity, methylene blue reduction test and infusoria (Rosenberger et al, 1979).

Statistical analysis of the data was done by Analysis Of Variance (ANOVA) using Statistical Analysis Systems (SAS Institute Inc., 1992). The data were presented as mean  $\pm$  standard error and the difference considered significant at  $p < 0.05$  and Highly significant at  $p < 0.01$ .

## Results

The encountered claw affections diagnosed with the different metabolic disturbances are pododermatitis aseptica diffusa (11), pododermatitis circumscripta non-purulenta (28), pododermatitis circumscripta purulenta (30), pododermatitis septica profunda (14), subclinical laminitis (12), podoarthritis (4), os pedis necrosis (4), phlegmona interdigitalis (7), dermatitis digitalis (4), dermatitis interdigitalis (8), hyperplasia interdigitalis (4), erosio unguulae (8), vertical crack (3), toe ulcer (3) and overgrown claws (3).

The results of the total blood picture showed that, in cows affected by alkalosis (abomasal displacement) associated with claw disorders, the proportion of segmented neutrophils was significantly ( $p < 0.05$ ) higher. In primary acetonaemia, the proportion of segmented neutrophils and eosinophils were significantly ( $p < 0.05$ ) higher. In hypocalcemia, the average haematocrit value, erythrocytic count and proportion of lymphocytes were significantly ( $p < 0.05$ ) lower. In hypophosphatemia, the average proportion of segmented neutrophils was significantly ( $p < 0.05$ ) higher whereas, the average haematocrit value was significantly ( $p < 0.05$ ) lower. In hypomagnesemia, the average total leukocytic count and the proportion of segmented neutrophils were significantly ( $p < 0.05$ ) higher whereas the average haematocrit value was significantly ( $p < 0.05$ ) lower. In fatty cow syndrome, the average total leukocytic count and the proportion of segmented neutrophils were significantly ( $p < 0.05$ ) higher whereas, the average haematocrit value was significantly ( $p < 0.05$ ) lower (table 1).

**Table 1: Total blood picture.**

Parameter	Alkalosis (N= 66)	Primary Acetonaemia (N= 16)	Hypocalcemia (N= 2)	Hypophosphatemia (N= 5)	Hypomagnesemia (N= 8)	Fat Cow Syndrome (N= 6)	Normal range
<b>Hb (g/l)</b>	100 ±3.14	107.4 ±7.56	94.5 ±9.65	111.8 ±13.25	101.4 ± 17.41	96.5 ± 6.87	80 - 120
<b>Hkt (l/l)</b>	0.3 ±0.04	0.323 ±0.21	0.265 ± 0.05*	0.284 ±0.08	0.287 ± 0.06	0.29 ±0.04	0.30 - 0.40
<b>RBCs (T/l)</b>	5.96 ±2.52	6.114 ±2.01	4.88 ± 1.08	5.952 ±1.02	6.027 ±2.47	5.86 ±3.21	5 - 8
<b>WBCs (G/l)</b>	9.81 ±4.12	9.187 ±3.04	13.2 ± 3.01*	8.32 ±2.14	10.86 ±3.45	10.92 ±4.78	5 - 10
<b>Eos. (%)</b>	2.621 ±0.56	6.125 ± 1.56 *	2 ±0.01	0.2 ±0.03	2.375 ±1.98	1.5 ±0.74	0 - 3
<b>Baso. (%)</b>	0.06 ±0.001	0.25 ±0.23	0	0	0.125 ±0.74	0	0 - 5
<b>Unseg. (%)</b>	2.469 ±1.02	3.75 ±1.94	2 ±0.1	1.4 ±0.04	4.75 ±1.96	2.333 ±0.58	0 - 5
<b>Seg. (%)</b>	53.53 ± 6.32 *	43.44 ±8.41	58.5 ± 11.4*	44.4 ±4.79	48.63 ± 7.96*	54.83 ± 9.45*	20 - 40
<b>Lym. (%)</b>	40.98 ±4.56	46 ±9.54	37.5 ±8.64	54 ±14.32	43.75 ±13.24	41.17 ±15.41	40 - 80
<b>Mono. (%)</b>	0.196 ±0.21	0.321 ±0.01	0	0	0.375 ± 0.08	0.166 ±0.07	0 - 5
<b>Juv. (%)</b>	0.06 ±0.01	0.125 ±0.02	0	0	0	0	0 - 5

Biochemical blood analysis revealed that, in cows affected by alkalosis (abomasal displacement) associated with claw disorders, the average CK, GLDH and TP values were significantly ( $p < 0.05$ ) higher. In primary acetonaemia, the average CK and GLDH values were significantly ( $p < 0.05$ ) higher. In hypocalcemia, the average urea was significantly ( $p < 0.05$ ) higher whereas, the average Ca was significantly ( $p < 0.05$ ) lower. In hypophosphatemia, the average CK, TP and bilirubin values were significantly ( $p < 0.05$ ) higher whereas, the average P was significantly ( $p < 0.05$ ) lower. In hypomagnesemia, the average CK, GLDH, TP and bilirubin values were significantly ( $p < 0.05$ ) higher whereas, the average serum Mg value was significantly ( $p < 0.05$ ) lower. In fatty cow syndrome, the average AST, GLDH and TP values were significantly ( $p < 0.05$ ) higher (table 2).

**Table 2: Blood serum biochemical parameters.**

Parameter	Alkalosis (N= 69)	Primary Acetonaemia (N= 16)	Hypoc- alcemia (N= 3)	Hypopho- sphatemia (N= 6)	Hypomag- nesemia (N= 10)	Fat Cow Syndrome (N= 6)	Normal range
<b>Ca (mmol/l)</b>	2.249 ± 0.45	2.205 ±1.4	1.75 ± 0.57*	2.168 ±1.07	2.222 ±0.97	2.376 ±1.02	2 - 3
<b>P (mmol/l)</b>	1.576 ±0.67	1.64 ±0.94	1.93 ±0.34	0.803 ± 0.54*	1.433 ±0.56	1.511 ±0.84	1.30 - 2.20
<b>Mg (mmol/l)</b>	0.825 ±0.16	0.838 ±0.24	0.726 ±0.27	0.786 ±0.34	0.519 ± 0.14*	0.696 ±0.34	0.60 - 1.30
<b>Na (mmol/l)</b>	138.7 ±15.42	137.8 ±24.57	136.2 ±20.89	142.5 ±30.47	139 ±25.10	137.7 ±14.79	130 - 150
<b>K (mmol/l)</b>	3.982 ±1.90	3.945 ±1.27	4.12 ±1.65	4.59 ±0.98	3.765 ±1.02	3.843 ±1.56	4.0 - 5.0
<b>AST (IU/l)</b>	72.09 ±6.57	54.63 ±6.78	52.33 ±8.79	71.33 ±8.97	79.6 ±9.24	106.2 ±18.75	0 - 100
<b>g-GT (IU/l)</b>	20.41 ±3.45	14.14 ±5.89	18.91 ±6.54	12.5 ±3.78	17.22 ±7.03	24.5 ±12.23	0 - 25
<b>CK (IU/l)</b>	161.5 ± 20.14*	165.8 ± 23.78*	143.5 ±22.47	247.7 ± 30.87*	176.3 ± 19.65*	54 ±14.65	0 - 60
<b>GLDH (IU/l)</b>	12.51 ±6.45*	9.575 ± 2.47	7.32 ±3.58	5.9 ±2.47	11.8 ± 7.21*	19.3 ± 8.21*	0 - 7
<b>TP (g/l)</b>	101.8 ± 9.85*	78.48 ±10.11	75.41 ±6.45	80.15 ± 9.84	88.28 ± 8.94*	102.1 ± 16.94*	60 - 80
<b>Bili (mmol/l)</b>	8.424 ±3.57	6.468 ±1.98	6.133 ±3.89	10.42 ± 4.21*	14.83 ±4.0*	7.65 ±3.05	0.30 - 8.50
<b>Urea (mmol/l)</b>	5.185 ±3.12	4.1 ±1.45	17.3 ± 6.47*	3.15 ±0.94	3.2 ±1.07	3.2 ±1.7	0 - 8.0

Concerning the blood clotting profile, the results showed that the recalcification, plasma thrombin, plasma thromboplastin and thromboplastogram reaction times were significantly ( $p < 0.01$ ) higher, Whereas, plasma fibrinogen was significantly ( $p < 0.01$ ) lower than the normal range (table 3).

**Table 3: Blood clotting parameters.**

The blood gases analysis revealed insignificant differences in all the examined parameters (table 4).

**Table 4: Blood gases parameters.**

The urine colour was light or darck yellow in 33.75%, light yellow or colourless in 28.75% or gold yellow in 35% of cows. The specific gravity was lower than 1.020 in all cows. The pH was lower than 7.0 degree in 27.71%, between 7.0 and 8.0 degree in 39.75% and more than 8.0 degree in 32.53%. The protein concentration was less than 15 mg / dl in 24.39%, between 15 and 20 mg / dl in 8.53%, 30 mg / dl in 47.56% and 100 mg / dl in 18.85% of cows. The ketone bodies concentration was lower than 15 mg / dl in 83.52%, 40 mg / dl in 4.71%, 80 mg / dl in 5.88% and 160 mg / dl or more in 4.71% of cows. The glucose concentration was less than 100 mg / dl in 91.76%. The bile pigments were abscent or only traces in 98.75%. The haemoglobin and red blood cells were abscent in 78.75%, 25 erythrocytes /  $\mu$ l in 8.75%, 80 erythrocytes /  $\mu$ l in 5% and 200 erythrocytes /  $\mu$ l in 7.50% of cows (table 5).

**Table 5: Urine examinations.**

The ruminal fluid colour was brownish green in 85.71% and grey olive in 14.28% of cows. The odour was aromatic in 95.77% and acidic in 4.22%. The ruminal fluid was viscous in 51.42% and watery in 47.14%. The pH values were between 6.2 and 7.2 degree in 47.82% and more than 7.2 in 52.17% of cows. The sedimentation and flotation activity was normal in 30%, absent in 32.85% and absent of flotation and rapide sedimentation in 37.14%. The methylene blue reduction time was shorter than 3 min. in 53.62%, longer than 3 min. in 36.23% and longer than 6 min. in 10.14% of cows. The infusoria was abundant in 22.85%, moderate in 38.57%, few in 22.85% and absent in 15.71% of cows (table 6).

**Table 6: Ruminal fluid examinations.****Discussion**

The encountered metabolic disturbances associated with claw disorders in this study were: alkalosis, primary acetonemia, hypocalcemia, hypophosphatemia, hypomagnesemia and fat cow syndrome.

In the present study, significant neutrophilia, increase in the levels of creatin kinase, glutamate dehydrogenase and total protein were associated with alkalosis. Significant eosinophilia and increase in the creatin kinase activity were associated with primary acetonemia. Leukocytosis, neutrophilia, decrease in haematocrit value, and increased urea level were associated with hypocalcemia. Significant increase in the creatin kinase and bilirubin values were found in hypophosphatemia. Neutrophilia, increased creatin kinase, glutamate dehydrogenase, total protein and bilirubin values were associated with hypomagnesemia. Neutrophilia, increased activity of glutamate dehydrogenase and level of total protein were associated with fat cow syndrome. Meanwhile, Nilsson (1963) found that in cows affected by acetonemia associated with claw disorders, the erythrocytic and total leukocytic count, magnesium and sodium were insignificantly higher, whereas, the proportion of basophils, immature neutrophils, monocytes, calcium and phosphorus were significantly low. Similar findings were recorded by Maclean (1965 / 1966 / 1970) who found that in cows affected by claw disorders associated with acetonemia the erythrocytic count, the total leukocytic count, proportion of basophils, immature neutrophils, monocytes and aspartate aminotransferase were within normal.

It has been suggested that hypocalcemia may cause adrenal cortical hyperactivity resulting in leukocytosis and neutrophilia. The increased bilirubin level in cases of hypophosphatemia indicate the presence of hepatopathy. Cows with fatty liver have increased blood concentration of liver-specific enzymes (Radostitis et al, 1994).

Acetonaemia is often associated with fatty infiltration of the liver or liver degeneration and this tissue damage might contribute a focus for increased histamine formation which predisposes to claw affections. The claw disorders and the associated acetonaemia may be due to abnormal ruminal bacterial fermentation which often occurs in connection with acetonaemia caused by a protein rich diet with unbalanced feeding. In this condition there are overgrowth of the physiological ruminal flora by bacteria of the coli and proteus strains which occur in alkaline pH and toxic products are formed (Nilsson, 1963 and Dirksen, 1983).

Also, the fatty acids formed in case of chronic latent ruminal acidosis may be shifted in favor of the proportion of butyric acid which can be transformed into beta-hydroxybutyric acid resulting in subclinical ketosis. Ruminal acidosis due to ration rich in easily digestible carbohydrates leads to many metabolic disorders such as metabolic acidosis, subclinical ketosis and fat cow syndrome. These metabolic changes can be considered in this respect as the primary factor in the pathogenesis of claw disorders. In case of claw disorders associated with ruminal acidosis, the toxic feed decomposition products absorbed from the rumen seem to cause severe circulatory disturbances in the claw corium with separation of the horny capsule from the third phalangeal bone (Dirksen, 1983). Meanwhile, Modrakowski (1978) found that metabolic and circulatory disturbances diminished blood supply and nutrition to claw corium leading to the manifestation of pododermatitis circumscripta.

The changes in the blood clotting profile indicate that there are marked microcirculatory disturbances in the claw corium. Nilsson (1963) and Boosman (1990) found that activation of the clotting system resulted from endotoxaemia, reflected by thrombocytopenia, increased PT, PTT and circulating soluble fibrin monomers could possibly lead to blockage of the claw microcirculation leading to laminitis. This supports the findings of Hofmann (1992) who described that in all forms of laminitis there is microcirculatory disturbances in the claw corium which may be due to allergic agents, endotoxin (histamine, lactic acid), bacterial toxins, blood acidosis. All these factors lead to direct damage of the endothelial cells or diffuse intravascular clotting and both lead to disturbances in the permeability of the capillaries resulting in destruction of the connection between the claw horn and the claw corium.

Regarding the concentrations of blood gases insignificant differences in the average oxygen tension, hydrogen carbonate concentration in plasma and actual base excess have been encountered. On the other hand Boosman (1990) found significant difference in the actual base excess in laminitic cows. This result means that there was no marked variations in blood gases parameters in relation to claw disorders.

The urine analysis indicated the presence of proteinuria with alkaline pH whereas ketone bodies has been encountered. Apparently, there was no marked specific changes in the urine parameters in relation to claw disorders. The changes of the ruminal fluid were more or less within the physiological range.

In conclusion it can be said that, the occurrence of claw affections in association with metabolic disturbances may be attributed to the metabolic and circulatory changes associated with ruminal acidosis, acetonaemia, fatty liver, hypocalcemia, hypophosphatemia and hypomagnesemia. These metabolic changes lead to the production of histamine, ketone bodies and lactic acid which causing severe microcirculatory disturbances in the claw corium. The microcirculatory disturbances leading to ischemic necrosis and degeneration of the horn producing structures and destruction of the connection between claw horn and corium predisposing to claw affections.

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## ***Appendices***

### **Programme**















## Exkursion nach El Fayoum

Prof. Dr. Farghal A. Zeid

Vizepräsident der Universität Kairo

### Einführung

Das Staatsgebiet der Arabischen Republik Ägypten erstreckt sich über eine Gesamtfläche von 1.001 Mio. km<sup>2</sup>. Es ist damit mehr als dreimal so groß wie die Bundesrepublik Deutschland. Mit über 63 Mio. Einwohnern ist Ägypten aber auch das bevölkerungsreichste Land des Nahen Ostens.

Die Lebensader Ägyptens ist der rund 6700 km lange Nil, der das Land auf einer Strecke von 1200 km von Süd nach Nord durchquert, bevor er in das Mittelmeer mündet. Entlang dieses Flußlaufes liegt, wenn man von einigen kleineren Oasen in den Wüsten des Landes absieht, fast das gesamte Kultur- und Siedlungsland, das nur rund 6% des Landes einnimmt. Mit einem mittleren Jahresniederschlag von 150mm an der Mittelmeerküste, 26mm in Kairo und 2mm in Assuan gehört Ägypten zu den trockensten Ländern der Erde. Landwirtschaft kann in Ägypten deshalb nur mittels Bewässerung betrieben werden. Als praktisch einzige Wasserressource hat der Nil damit eine lebenswichtige Bedeutung für Ägypten. Das durch Ägypten nutzbare Wasser des Nils ist jedoch nicht unbegrenzt. In den vergangenen hundert Jahren wurde durch verschiedene Baumaßnahmen, deren letzte große der Bau des (Sadd el-Ali) Hochstaudamms bei Assuan war, versucht, das Wasserangebot zu erhöhen. Es liegt bei 55,5 Mrd m<sup>3</sup>/Jahr.

### Provinz Fayoum

Der Name der Provinz wird im allgemeinen von dem koptischen „Phiom“ in der Bedeutung von „das Meer“ hergeleitet. Im übertragenen Sinn wird Fayoum also als das Seeland oder die Seeprovinz bezeichnet. Fayoum ist eine große Oasensenke. Sie liegt 100 km südwestlich von Kairo abseits vom Niltal. Sie wird durch die Koordinaten 30° 20' und 31° 10' der Längengrade und 29° 2' und 29° 35' der Breitengrade begrenzt und bildet eine blattförmige Depression in der libyschen Wüste. Der Zugang nach Fayoum erfolgt über drei Straßenverbindungen, deren wichtigste im Nordosten die Wüstenstraße nach Kairo und im Südosten die Straße nach Beni Suef im Niltal sind, sowie über eine Eisenbahnlinie im Osten von Fayoum.

Die Gesamtfläche beträgt 1827 km<sup>2</sup> bzw. 435000 fd. Davon sind ca. 72% (315000 fd) Kulturland, 13% offene Wasserflächen (die Seefläche nimmt 240 km<sup>2</sup> bzw. 58000 fd ein) und 15% Siedlungs- und Brachland, Sumpf oder Wüste. Die Hauptstadt des Regierungsbezirkes ist Medinet El-Fayoum. Die besiedelte Fläche ist in fünf Verwaltungseinheiten gegliedert, die den fünf großen Staaten des Fayoum entsprechen. Diese sind im Norden Senores, Ibschaway im Nordwesten, Tamia im Nordosten, Itsa im Süden und El-Fayoum im Zentrum.

Die Gesamtbevölkerung beträgt rund 2,1 Mio., was 3% der ägyptischen Bevölkerung entspricht, die Einwohnerdichte ist 1150 EW/km<sup>2</sup>. Davon leben 23% in den Städten und 77% in den ländlichen Gebieten Fayoums. Das Bevölkerungswachstum der Provinz wird auf 3,2% geschätzt. Fayoum ist eine der ältesten landwirtschaftlich genutzten Regionen Ägyptens, nämlich seit der 12. Dynastie (2000 v. Chr.). Sie wurde

durch die Überflutung des Nils gebildet. Die Oberfläche des Fayoum senkt sich nach Nordwest. Sie fällt in etwa von der Höhe des Niltales, wo der Bahr Jusef bei Lahun mit +25 m in das Fayoum eintritt auf das Niveau des Birket Qarun (Qarun = See), dessen Wasserspiegel um - 45 m schwankt, ab. Das Durchschnittsgefälle beträgt im zentralen Teil nach Nordwesten 0,1% und direkt am Qarun-See 0,2%. Im Osten und Westen steigt das Gefälle bis auf 0,7%.

### **Der Qarun See**

Am Ende des in sich geschlossenen hydrographischen Systems in Fayoum steht der Qarun-See. Er ist ein abflußloser, großer Endsee und nimmt den tiefstgelegenen Teil im Norden der Oase Fayoum ein. Die maximale Länge beträgt rund 45 km und an der breitesten Stelle ist er ca. 8,5 km breit. Die Oberfläche beträgt bei einem Seespiegel von - 45 m 214,4 km<sup>2</sup>. Die maximale Tiefe wird mit 8,6 m erreicht. Für seine Größe ist der Qarun-See relativ flach, denn die Durchschnittstiefe liegt bei 4,2 m. Der tiefste Punkt der Senke liegt somit auf der Höhenlinie und 53m, unter NN. Streng genommen ist es nicht korrekt, die ganze Oase Fayoum als Depression zu bezeichnen, da nur ein Teil des Gebietes unter dem Meeresspiegelniveau liegt. Das Niveau der Seespiegels schwankt im Laufe des Jahres und der Jahre. Es hat sein Maximum im März / April und das Minimum im September / Oktober. Die Differenz zwischen Maximal- und Minimalstand liegt zwischen 30 und 70 cm. Für die letzten 30 Jahre läßt sich mit großen Schwankungen ein deutlicher Anstieg des Wasserspiegels um insgesamt 80 cm beobachten. Das läßt sich zum einen auf eine erhöhte Bewässerung seit dem Bau des Assuan Staudammes und intensivere Landwirtschaft zurückführen, zum anderen aber auch auf ein besonders auf der Farmebene schlechter werdendes Wassermanagement.

Auf dem gegenwärtigen mittleren Niveau von - 43,81 m beträgt die Größe der Wasseroberfläche ca. 253,25 km<sup>2</sup> und das Volumen 1040 Mio. m<sup>3</sup>. Der See wird hauptsächlich von Drainagewasser gespeist. Dazu kommen ein mengenmäßig kleinerer Sickerwasserzustrom und eine Grundwasserspeisung. So wird immer wieder über Wasserturbulenzen (bzw. Quellen) in der Nähe der Insel berichtet. Ehemals war der Qarun-See ein Süßwassersee, in dem Nilfische lebten. Durch die Verdunstung und durch zunehmend salzigeres Drainagewasser akkumulierte sich im Laufe der Zeit Salz im Seewasser. Um die Jahrhundertwende wurde er salzig mit 8000 mg/l (Frischwasser zwischen 500 und 1500 mg/l). 1909 betrug der Salzgehalt 10500 mg/l, 1928 schon 22000 mg/l. Zu diesem Zeitpunkt mußten für die Fischerei Salzwasserfische aus dem Mittelmeer in den See eingesetzt werden. Bis 1979 verdreieinhalbfachte sich der Salzgehalt auf 38300 mg/l, das sind 10% mehr als im Mittelmeer.

### **Wadi el Rayan See**

Er liegt im Südwesten von Fayoum. Die Breite beträgt ca. 15 km, die Fläche ungefähr 700 km<sup>2</sup>. Der Wadi el Rayu besteht aus drei aufeinanderfolgenden Teilbecken. Eine Verbindung zum Nil besteht nicht. Der Wadi el Rayan See dient als Überflussspeicher für die großen Seen im Fayoum.

## Wasserbilanz

Da das Fayoum ein geschlossenes System darstellt, lassen sich die Komponenten einer Wasserbilanz relativ gut quantifizieren.

Die Wasserbilanz des Fayoum setzt sich zusammen aus:

- a) Wasserzufuhr über Niederschlag und Bewässerungswasser von Bahr Jussef in Lahun
- b) Wasserverluste durch
  - Evaporation von offenen Wasseroberflächen
  - Evaporation des Qaun Sees
  - Evaporation und den Pflanzenwasserverbrauch
  - Drainageabfluß zum Wadi Rayan.

Bilanzveränderungen zeigen sich in einer Änderung des See- und Grundwasserspiegels.

## **Presse-Echo**

## Studium in Deutschland – Hochschulkarriere in Ägypten

*Ergebnisse einer Befragung im Rahmen des Symposiums-cum-Workshop  
„Sustainable Agriculture and Rural Development in Egypt, Experiences of Egyptian  
Graduates from German Universities“, Cairo  
20 - 26. November 1999*

Siawuch Amini

### Einleitung

Der Deutsche Akademische Austauschdienst (DAAD) stellt seit 1999 den deutschen Hochschulen finanzielle Mittel zur Verfügung, um die Betreuungsaktivitäten systematischer und umfassender durchführen zu können und Netzwerke der ehemaligen ausländischen Absolventen/innen der deutschen Hochschulen auszubauen sowie zusammen mit den Alumni wissenschaftliche Tagungen zu organisieren.

Die Hauptziele dieser Tagungen sind:

- Gedanken- und Erfahrungsaustausch zwischen den deutschen und ausländischen Wissenschaftler/innen und langfristige Sicherung der Kontakte zwischen deutschen und ausländischen Hochschulen und wissenschaftlichen Einrichtungen sowie
- Ausbau gemeinsamer Alumni-Netzwerke in den ausländischen Hochschulen und wissenschaftlichen Einrichtungen.

Gefördert wurde in diesem Rahmen vom DAAD der Auf- und Ausbau eines fachbezogenen regionalen Netzwerkes von ägyptischen und aus dem benachbarten arabischen Sprach- und Kulturkreis stammenden Studien- und Promotionsabsolventen/innen deutscher Hochschulen in Verbindung mit der Durchführung von Nachkontakt-Expertenseminaren und Fortbildungsmaßnahmen in Ägypten auf der Grundlage der Weiterentwicklung und Vernetzung bestehender Alumni-Datenbanken der Universität Göttingen und der Universität Kassel-Witzenhausen. Ein entsprechendes „follow-up meeting“ fand im Herbst 1999 in Kairo mit dem Titel „International Symposium-cum-Workshop, Sustainable Agriculture and Rural Development in Egypt, Experiences of Egyptian Graduates from German Universities“ statt.

In diesem Rahmen wurde eine Befragung der Teilnehmer/innen durchgeführt, deren Ergebnisse in diesem Bericht dargestellt werden sollen.

### Hintergrund der Befragung

Das Interesse der deutschen Hochschulbildungspolitik am Ausländerstudium hat in den letzten Jahren an Aktualität gewonnen. Sie ist gekennzeichnet durch eine Reihe von grundlegenden Veränderungen, die, bei näherer Betrachtung, zu einer Sonderstellung des Studiums von Ausländern/innen in den deutschen Hochschulen geführt haben. Das deutsche Bildungssystem der Nachkriegsjahre zeichnete sich dadurch aus, dass Ausländer/innen hier den gleichen Bedingungen des Studiums unterworfen waren wie ihre deutschen Kommilitoninnen und Kommilitonen. Das Bildungssystem

machte hier keinen Unterschied. Die französischen, belgischen und teilweise englischen Bildungssysteme hatten auf Grund ihrer kolonialen Erfahrungen ihre Bildungssysteme so eingerichtet, dass es für die ausländischen Studierende eine Anzahl von Möglichkeiten gab, gestufte Bildungssysteme zu durchlaufen, die für die Ausländer/innen zwar einen hohen Stellenwert besaßen, für die Einheimische jedoch eine untergeordnete Rolle spielten (in der Promotion bsp. die Unterscheidung zwischen Dr. troisième cycle, Dr. d'état und Dr. d'université).

Über die Vor- und Nachteile dieser unterschiedlichen bildungspolitischen Aspekte gibt es selbstverständlich eine Menge von Thesen, auf die hier im Einzelnen nicht eingegangen werden kann. Im Bereich der deutschen Bildungspolitik ist in den letzten Jahren infolge der zahlreichen Erschwernisse für Ausländer die Frage des „Bildungsstandortes Deutschland“ kontrovers diskutiert worden. Die entsprechenden Debatten haben dazu geführt, dass für die ausländischen Studierenden immer mehr neue Studiengänge (hauptsächlich 2. Studienstufe) eingerichtet wurden, die als Kurzstudiengänge bekannt geworden sind. Diese werden teilweise in englischer Sprache angeboten. Im Bereich der Promotion wurden Sandwich-Systeme, Channel-Systeme etc. eingeführt, um in möglichst kurzer Zeit den Abschluß für die ausländischen Studierenden zu ermöglichen.

Ein wesentliches Merkmal des deutschen Hochschulsystems in der Vergangenheit war vergleichsweise schwach entwickeltes Nachkontaktsystem für ehemalige Absolventen/tinnen der deutschen Hochschulen. Zwar ist die Anzahl der Studien über die wirtschaftlichen, politischen, sozialen und psychischen Probleme der ausländischen Studierenden in Deutschland sehr groß (s. hierzu v.a. Danckwort), es gibt jedoch nur wenige Studien über den Verbleib der Absolventen/innen und die Wirkungsanalysen des Studiums in Deutschland.

Einige Gründe für diesen Umstand liegen in der mangelnden Institutionalisierung durch die deutschen Hochschulen und infolgedessen fehlende detaillierte Datenbanken und formalisierte Kontakte zu den ehemaligen ausländischen Studierenden und dem hohen Aufwand, der für die kontinuierliche Aktualisierung der Adressen notwendig sind. Auf der anderen Seite ist die Forschung auf diesem Gebiet nur wenig gefördert worden. Die wenigen Informationen darüber sind eher Bemühungen einzelner Wissenschaftler/innen zu verdanken, die nur gelegentlich und sporadisch solche Studien angefertigt haben. Interessanterweise trifft dies in Deutschland nicht nur bei den ausländischen, sondern auch streckenweise bei den deutschen Absolventen/innen zu. Der Grund liegt wiederum darin, dass der Wirkung derartiger Verbleibsstudien ein geringer Wert beigemessen wird. Die Erwartungen, die an diesen Studien gestellt werden, können nicht erfüllt werden, weil die Universitäten es bisher nicht als ihre primäre Aufgabe gesehen haben, ihr Curriculum den Veränderungen der Praxis anzupassen und die Hochschulbildung nach den Anforderungen der Gesellschaft zu richten. Als Argument für diesen Sachverhalt gilt die Tatsache, dass diese Aufgabe aus der Sicht der Hochschulen eher den Fachhochschulen zufällt, die hierzu die strukturellen Bedingungen erfüllen. Diese Debatte kann im Hinblick auf die Vor- und Nachteile dieser Haltung natürlich kontrovers geführt werden. Sicher ist jedoch, dass der Druck auf die Hochschulen in dieser Richtung wächst und die gesellschaftliche Forderung nach dem praktischen Sinn des Studiums immer lauter wird. Entsprechend werden die Forderungen nach Veränderungen in den Hochschulen immer aktueller.

In den letzten Jahren ist Bedeutung des Ausländerstudiums in Deutschland im Hinblick auf seine Wirkung und auf die Intensivierung der Kooperation stark gestiegen, in der Praxis fehlen jedoch ausreichende Erkenntnisse und Erfahrungen für die Kontaktaufnahme und infolgedessen für die organisatorische Gestaltung einer nachhaltigen und effizienten Zusammenarbeit.

Angesichts einer hohen Anzahl der Teilnehmer/innen des Symposiums in Kairo bot sich die Gelegenheit, eine Befragung der Teilnehmer/innen durchzuführen. Folgende Ziele standen dabei im Vordergrund:

- Erstellung einer Datenbank auf der Basis der aktuellen Angaben der Befragten zu ihrer eigenen Person
- Erschließung der Gründe für die Wahl Deutschlands als Studienort
- Erkundung des Studienverlaufs in Deutschland einschließlich der Beurteilung des Studiums in unterschiedlichen Phasen (1., 2. Stufe sowie Promotion) im Inhalt und in der Anwendung
- Informationsgewinnung zu Fragen der Weiterbildung und ihrer Beurteilung
- Erkenntnisgewinnung zu Fragen des Berufsverlaufs nach dem Studium in Deutschland
- Datenerhebung zu Fragen der aktuellen Beschäftigungssituation
- Feststellung der Kontakte und Nachkontakte der Teilnehmer/innen zu ihrer (n) deutschen Universität(en)
- Erfassung der Beurteilung einer Netzwerkbildung und der Bereitschaft zur Mitarbeit

## Zur Methode

Der Fragebogen wurde in den Tropenzentren Göttingen und Kassel-Witzenhausen entwickelt, um die o.g. Ziele zu erreichen. Er wurde am Rande der Veranstaltung verteilt und von den Teilnehmer/innen ausgefüllt. Im Nachhinein zeigten sich jedoch einige Probleme, die hauptsächlich durch die deutsche Sprache bedingt waren. Viele Teilnehmer/innen, vor allem diejenigen, die nach dem Channel- oder dem Sandwich-System studiert oder promoviert haben, hatten große Mühe, sich durch den umfangreichen Fragebogen durchzuarbeiten. Zudem waren die Fragen für die Adressaten etwas komplex formuliert. Aufgrund der hohen Intensität und der Dichte der Themen des Symposiums konnte leider keine Sonderveranstaltung zur Befragung eingeschoben werden, um Hilfeleistung bei der Ausfüllung des Fragebogens zu geben und die Bedeutung und den Sinn der Befragung zu klären. Deshalb wurden die Fragebögen teilweise unvollständig und teilweise mißverständlich ausgefüllt. Bei der Eingabe der Daten mittels SPSS gab es Schwierigkeiten, eine weitgehend überzeugende Codierung vorzunehmen, so dass die Daten größtenteils als qualitative Angaben eingegeben werden konnten und dadurch auch nur qualitativ auswertbar waren. Eine quantitative Analyse in Form von Kreuztabellen für die tief liegenden Ursachen der deskriptiven Analyse konnte nicht durchgeführt werden. Die relative hohe Anzahl der unbeantworteten Fragen ist nicht als eine Antwortverweigerung zu bewerten, sondern vielmehr als Beleg für die unverstandenen Fragen. Dafür spricht die Tatsache, dass die im Zusammenhang formulierten Fragen gleichermaßen unbeantwortet geblieben sind. Zudem lagen einige Antworten auf die gestellten Fragen nicht auf der gleichen Ebene, so dass eine Vergleichbarkeit der Antworten nicht möglich war.

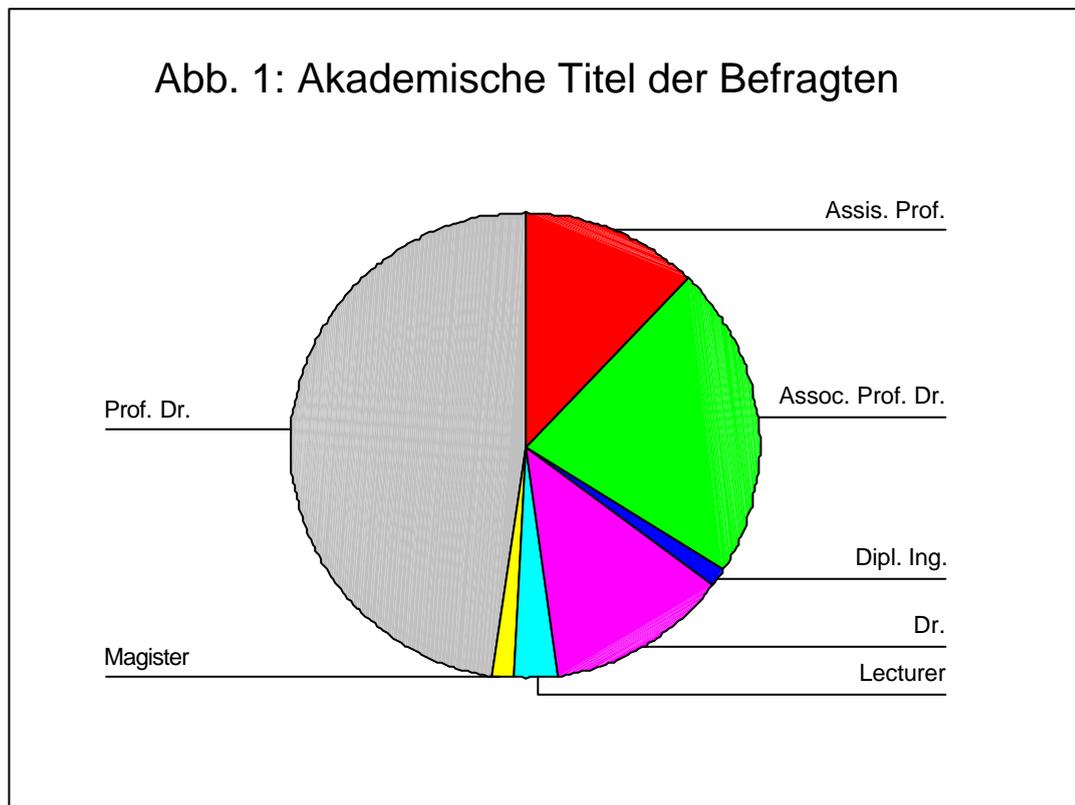
Trotz dieser Schwierigkeiten konnten brauchbare Hypothesen für die künftige Datensammlung auf diesem Gebiet formuliert werden. Zu dem gab es besonders interessante Ergebnisse dieser Befragung.

Auf der Basis der Erkenntnisse dieser Befragung ist für die Zukunft die Formulierung des Fragebogens auch in arabischer Sprache und eine entsprechende Informationsveranstaltung geplant, damit eine möglichst lückenlose Informationsgewinnung gewährleistet werden kann.

## Ergebnisse der Befragung

Verteilung der Befragten nach akademischem Titel

Von insgesamt 81 *anwesenden* Teilnehmern/Innen zur Zeit der Befragung auf dem Symposium haben 65 den Fragebogen ausgefüllt. Dies entspricht 80% der Anwesenden. Rechnet man die Zahl der Teilnehmer/innen anhand der ausgestellten Zertifikate (140), ergibt sich allerdings eine 46% Beteiligung an der Fragebogenaktion. Bei den Befragten handelt es sich bei 78,5% um Professoren und Professorinnen mit hohen Positionen von 10 unterschiedlichen ägyptischen Universitäten.



Die Angaben der Titel wurden von den Befragten übernommen. Inwieweit der Titel „Prof. Dr.“ (das graue Feld in der Abbildung 1) nach Assistant Prof. und Associated Prof. differenziert werden kann, konnte im nach hinein nicht ermittelt werden. Bei den Angaben Dr., Dipl.Ing, Lecturer und Magister scheint es sich jedoch um Assistenten zu handeln.

## Akademische Abschlüsse in Ägypten und Deutschland

Wie aus der Tabelle 1 zu entnehmen ist, haben 10,8% der Befragten ihre 1. Studienstufe mit BSc/BA/Bvet, 55,6% haben mit Master und 30,8% mit PhD in Ägypten abgeschlossen. Vergleicht man diese Zahlen mit den Abschlüssen in den deutschen Hochschulen in der

Tab. 1: Akademische Abschlüsse der Befragten in Ägypten

	Akad. Abschlüsse in Ägypten	Statistiken Häufigkeit	Prozent	Gültige Prozente	Kumulierte Prozente
Gültig	BSc/BA/Bvet	7	10,8	11,1	11,1
	BSc+Msc	36	55,4	57,1	68,3
	BSc+MSc+PhD	20	30,8	31,7	100
Gesamt		63	96,9	100	
Fehlend		2	3,1		
Gesamt		65	100		

Tabelle 2, so zeigt sich eindeutig, dass in fast allen Fällen die Grundlage der Promotion in Deutschland der Abschluß Master in den Heimatuniversitäten war. Auf der anderen Seite mußten die ägyptischen Diplome oder Master in Deutschland nachgeholt werden (s. unter Dr.+Sonstiges und Diplom und später unten).

Lediglich in 2 Fällen ist das Studium in den USA und Holland abgeschlossen worden. 43% haben angegeben, dass sie vor dem Studium in Deutschland einen Abschluß in der Heimat erlangt haben.

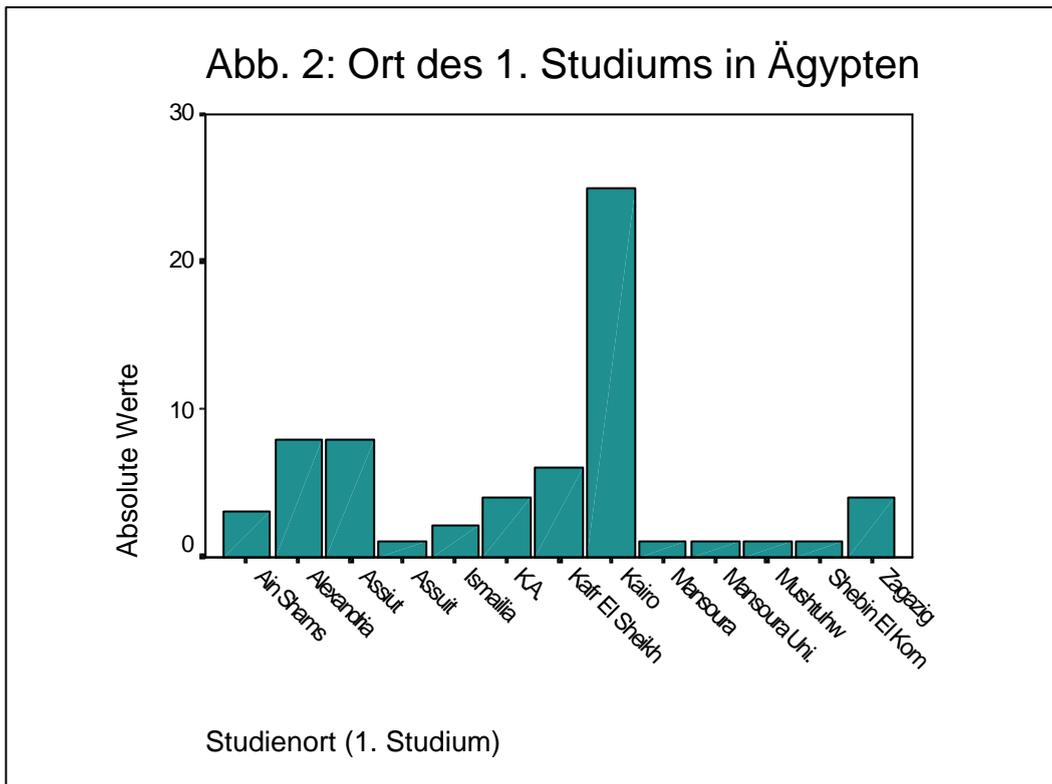
Tab. 2: Akad. Abschlüsse in Deutschland

	Akad. Abschlüsse in Deutschland	Häufigkeit	Prozent	Gültige Prozente	Kumulierte Prozente
Gültig	Diplom	2	3,1	3,3	3,3
	Dr.	39	60	63,9	67,2
	Sonstiges, z. B. HD-Kurs, BV-Kurs	3	4,6	4,9	72,1
	Diplom+Dr.	1	1,5	1,6	73,8
	Dr.+Sonstiges	11	16,9	18	91,8
	Diplom+Dr.+Sonstiges	3	4,6	4,9	96,7
	MSc+Dr.+Sonstiges	1	1,5	1,6	98,4
	Diplom+MSc+Dr.+Sonstiges	1	1,5	1,6	100
	Gesamt	61	93,8	100	
Fehlend	System	4	6,2		
Gesamt		65	100		

### Studienfächer beim 1. Abschluß

Bis auf 15 Fälle (12 Veterinärmedizin, 2 Bauingenieurwesen und 1 Biochemie) haben die meisten Befragten ihren 1. Abschluß im grünen Bereich absolviert. Die Angaben gehen von allgemeiner Landwirtschaft bis zu Garten- und Forstbau und Lebensmitteltechnologie; die meisten jedoch im Bereich Pflanzenbau (Pflanzenschutz) und Tierhaltung.

Die Abschlüsse an den Universitäten in Ägypten lassen sich aus Abbildung 2 ablesen:



Das Studium in der Heimat hat bei den meisten Befragten 4 Jahre gedauert. Jedoch sind Studienzeiten zwischen 5 und 6 Jahren, die zum 1. Studienabschluß (BSc./BA/Bvet) führen, auch stark vertreten. Die relativ lange Studienzzeit in der Heimat ( $\bar{x}$  4,47 J.) und die zusätzlichen Studienjahre in Deutschland (Nachholen von Diplomarbeit, Zusatzprüfungen und Promotion) werfen die Frage nach der Verhältnismäßigkeit der Studiendauer auf.

Ohne Berücksichtigung des Nachholens von Sonderprüfungen ist das Studium der Ägypter/innen bis zur Promotion ohnehin sehr lang. Entsprechend ist die Dienstzeit in der Universität relativ kurz. Die Abbildung 3 verdeutlicht die Studiendauer in der Heimat.

Der 1. Studienabschluß mit hohem Anteil an BSc. 78,4 % ist in der Tab. 3 wiedergegeben.

*Tab. 3: Abschlussgrad (1. Studium)*

	Akad. Abschlüsse in Deutschland	Häufigkeit	Prozent	Gültige Prozente	Kumulierte Prozente
Gültig		6	9,2	9,2	9,2
	B. Sc.	51	78,4	78,4	87,6
	B. V. Sc.	4	6,2	6,2	93,8
	B. Vet. Med.	4	6,2	6,2	100
	Gesamt	65	100	100	

Aus der Altersverteilung läßt sich diese Aussage untermauern. Wie die Tabelle 3 zeigt, liegt die häufigste Altersgruppe zwischen 41 und 50 Jahren, gefolgt von der Gruppe der 51- bis 60-jährigen. Nur 26,2 % liegen zwischen 31 und 40 Jahren (Tab. 4).

*Tab. 4: Die Altersverteilung der Befragten*

	Alter	Häufigkeit	Prozent	Gültige Prozente	Kumulierte Prozente
Gültig	bis 40	17	26,2	26,2	26,2
	bis 50	28	43,1	43,1	69,2
	bis 60	19	29,2	29,2	98,5
	darüber	1	1,5	1,5	100
	Gesamt	65	100	100	

In der zusammenfassenden Analyse wird auf dieses Phänomen noch detailliert eingegangen.

## Gründe für die Auswahl Deutschlands als Studienort

Eine Vielzahl detaillierter Angaben sind zur Auswahl Deutschlands als Studienort gemacht worden, die bei der Analyse in folgenden Kategorien zusammengefasst werden konnten:

Die generelle **Reputation** Deutschlands als Studienort in der Welt und in Ägypten

Der Stand der **Technologie** und Know How in Deutschland

Die **Eignung** der deutschen Universitäten im Umgang mit Neuheiten in der Wissenschaft

Persönliche und **kulturelle** Erwägungen (inkl. Beziehungen über den Dozenten)

**Stipendium** von Deutschland bzw. von Ägypten zum Studium

Die erste Kategorie wird untermauert mit Angaben wie: „*Deutschland ist sehr bekannt als Großstaat in der Welt*“, „*nach dem Studium in Deutschland bekommt man in Ägypten schneller einen Job*“, „*Deutschland ist führend in der Welt in meinem Fachgebiet*“, „*Deutschland ist führend in der Lehre und Forschung*“ und dgl.

Zu der Kategorie 2 werden Angaben gemacht wie: „*Ein Land mit Hochtechnologie*“, „*Hohe Technik der Wissenschaft und der Methode und der Literatur*“, „*High Tech Apparate und Geräte und Labors*“, „*Ein Land mit hoch entwickelter Technologie*“, „*High Tech; High Quality; High Materials & Methods*“ und dgl.

Die Kategorie 3 bezieht sich auf die Eignung von Deutschland für Neuheiten und Neuigkeiten in der Welt der Wissenschaften. Dazu werden Angaben wie folgende gemacht: „*Neue praktische Anwendung der Wissenschaft*“, „*Neue und ökologische Methoden des Pflanzenschutzes*“, „*Deutschland ist bestens geeignet für meine neue Fragestellung*“ und dgl.

In der Kategorie 4 werden Angaben gemacht wie „*Erlernen der deutschen Sprache und Kultur*“, „*Deutsche Kultur als Motivation zum Studium*“, „*Ich war als Junge in Deutschland gewesen*“, „*Deutschland war immer mein Traum*“, „*Ich war begeistert von der deutschen Sprache und dem deutschen Volk*“, „*Mein Professor war auch in Deutschland*“ und dgl.

Die etwas passivere Begründung der Auswahl schließlich bezieht sich auf das *Stipendium von Deutschland oder von der ägyptischen Regierung bzw. vom DAAD*.

In der folgenden Tabelle werden jeweils die Nennungen (inkl. Mehrfachnennungen) wiedergegeben:

Tab.5: Gründe für die Auswahl Deutschlands zum Studium

Kategorie	Häufigkeit	% der Nennungen
1. Reputation	28	28,58
2. Technologie	23	23,47
3. Eignung	17	17,34
4. Kultur	16	16,32
5. Stipendium	14	14,29
S	98	100

## Erster Studienverlauf in Deutschland

52 der 65 Befragten hatten keinerlei Probleme bei der Zulassung zum Studium in Deutschland. 4 geben jedoch Probleme an und 9 äußern sich nicht zu dieser Frage. Bei diesen 4 Fällen handelt es sich um Sprach- und Anerkennungsprobleme.

Die deutsche Sprache lernten die meisten in den Goethe-Instituten in Deutschland und Ägypten (Mannheim 9, Staufen/Freiburg 8, Göttingen und Bremen je 7, Kairo und

Alexandria 8, Rothenburg u. Schwäbisch Hall je 4, Beuren 2, Gießen, Boppard und Prien je 1. Die restlichen Befragten haben im Herder-Institut in Leipzig, in den Volkshochschulen und in den Sprachkursen der Universitäten Deutsch gelernt. 54 Befragte (83%) haben dabei ein Zertifikat der deutschen Sprache erworben. Trotz dieser hohen Beteiligung an Kursen, scheint das Erlernen deutscher Sprache, wie wir später noch sehen werden, eines der wichtigsten Probleme bei den Befragten gewesen zu sein.

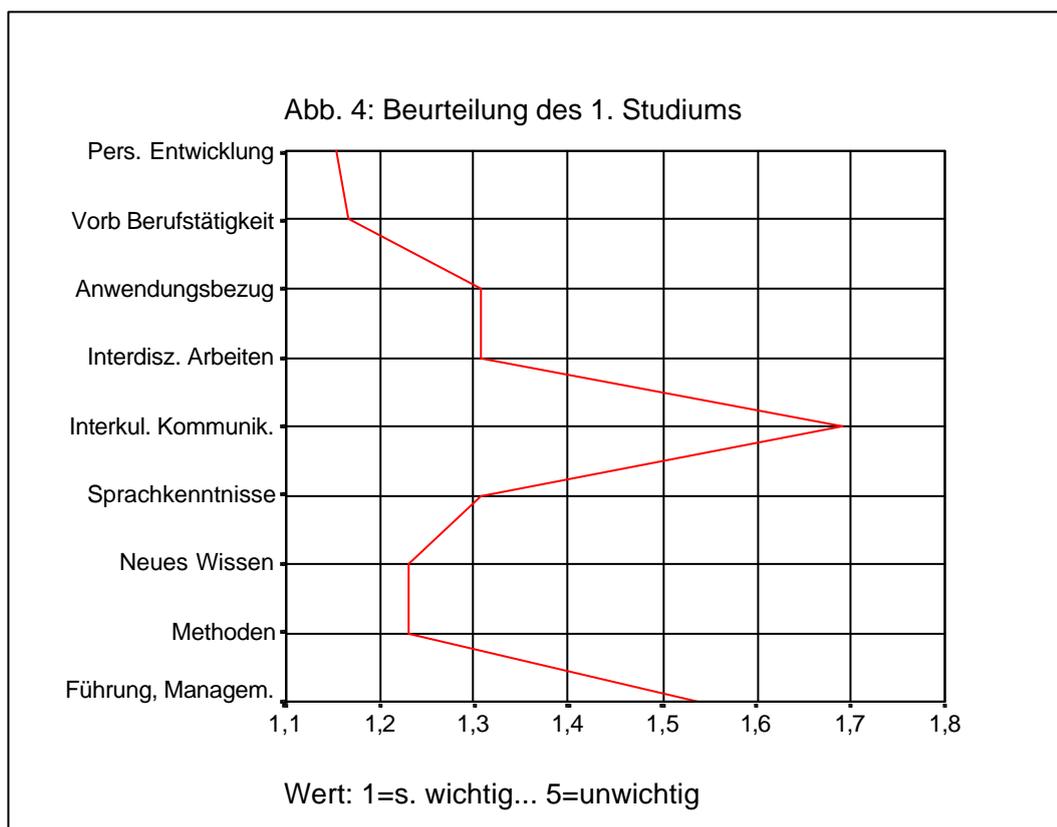
Nur in acht Fällen werden Angaben zum ersten abgeschlossenen Studium in Deutschland gemacht. In 4 Fällen wurde in Deutschland das Diplom gemacht. In einem Fall gab es ein Aufbaustudium und in den restlichen drei Fällen wurden Kenntnisprüfungen gemacht und einige Fächer nachgeholt.

Der erste Abschluß in Deutschland hat bei den Betroffenen im Durchschnitt 2 Jahre gedauert. In zwei Fällen sogar 3 und 4 Jahre. Das 1. Studium in Deutschland wurde in 6 Fällen durch den DAAD und in den weiteren Fällen privat finanziert.

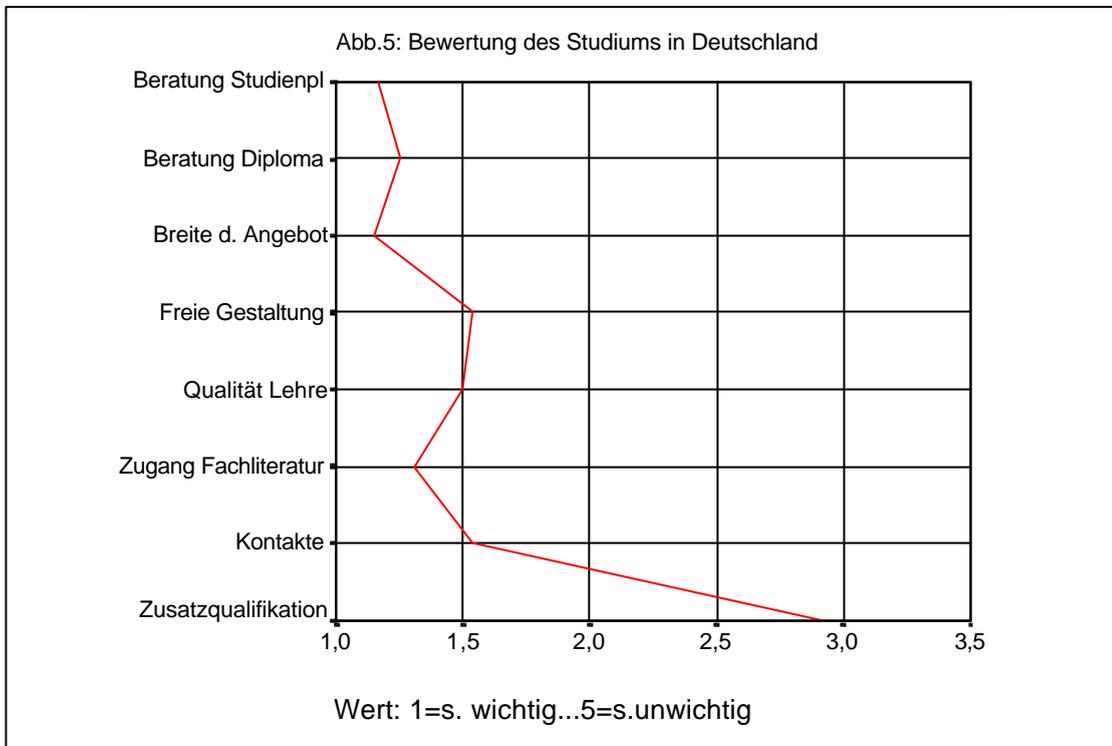
## Einschätzung des Nutzens des Studiums in Deutschland

Der Nutzen des 1. Studiums in Deutschland (N=9) wurde in einer Intervallskala und im Hinblick auf die persönliche Entwicklung, Vorbereitung auf Berufstätigkeit, Anwendungsbezug, interdisziplinäres Arbeiten, interkulturelle Kommunikation, Sprachkenntnisse, neues Wissen und schließlich Methoden und Arbeitsinstrumente abgefragt. Die aggregierten Ergebnisse (Mittelwerte) wurden ermittelt und in der Abb. 4 dargestellt. Wie aus dieser Abbildung zu entnehmen ist, liegen die Durchschnittswerte ausschließlich im Bereich von wichtig bis sehr wichtig mit sehr geringer Standardabweichung.

Besonders wichtig war das 1. Studium für die persönliche Entwicklung und für das Aneignen von neuem Wissen, weniger die interkulturelle Kommunikation und Methoden.



Nach dem selben Verfahren wurde die Beurteilung und Bewertung des 1. Studiums in Deutschland im Hinblick auf die Beratung und Betreuung bei der Studienplanung und Fächerwahl und bei der Magister/Diplomarbeit, die Breite des Studienangebots,



Möglichkeiten zur freien Gestaltung des Studiums, Qualität der Vermittlung der Lehrinhalte, Zugang zur Fachliteratur/Bibliothek, Kontakte zu anderen Studierenden, Möglichkeiten, am Rande des Studiums zusätzliche Qualifikation zu erwerben, abgefragt. Die Ergebnisse in Form von aggregierten Mittelwerten ist in der Abbildung 5 wiedergegeben.

Die Grafik zeigt eindeutig, dass das 1. Studium erwartungsgemäß wenig Raum für den Erwerb von Zusatzqualifikationen für die Betroffenen zulässt.

Die Beurteilung des 1. Studiums in Deutschland fällt jedoch im Hinblick auf die aufgeführten Kategorien äußerst positiv aus.

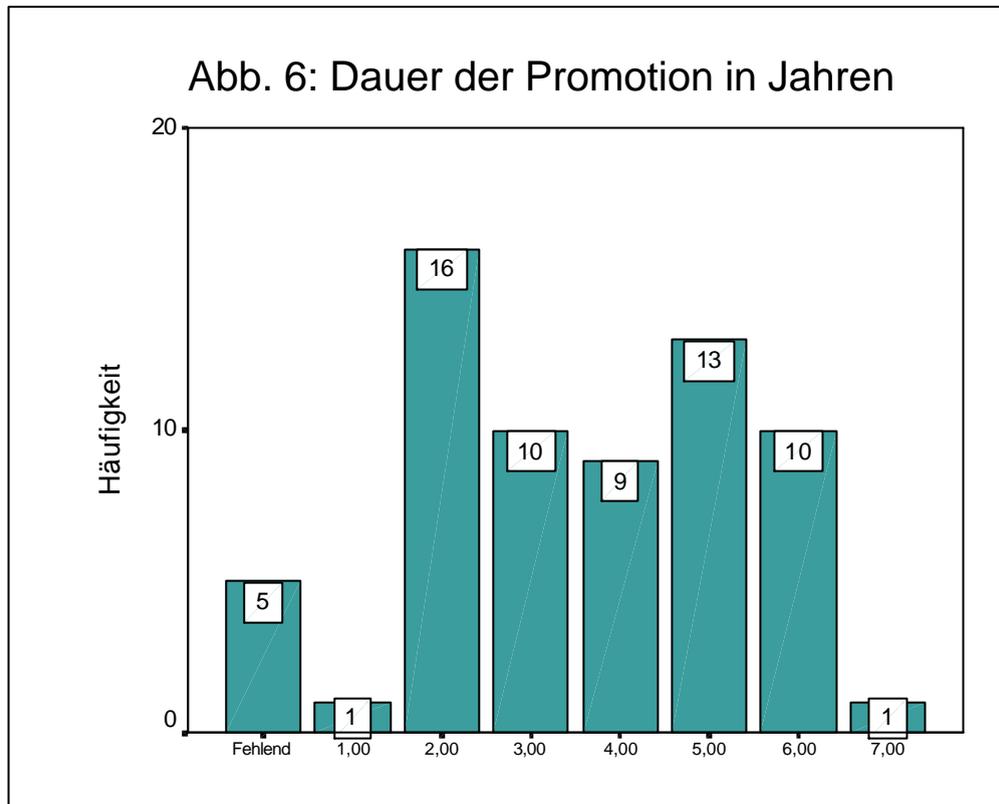
## Das Promotionsstudium

Von den 65 Befragten haben 12 an der Universität Göttingen, 11 an der Universität Gießen, 9 an der Universität Berlin, 8 an der Universität Hannover, 6 in München promoviert. Die Schwerpunkte liegen in verschiedenen Fachrichtungen der Agrarwissenschaften und der Veterinärmedizin.

Die Frage nach der Art des Promotionsstudiums brachte zwar eine Antwort, die Ebene der Antwort wurde jedoch leider nicht einheitlich gehalten, so dass hier keine definitive Vergleichbarkeit vorliegt. Trotzdem lassen sich 13 Fälle von Channel-Studium und 35 Fälle von Vollzeitpromotionsstudium ableiten. Da die Ebenen ineinander fließen, konnte nicht festgestellt werden, in wie vielen Fällen die Promotion durch den DAAD

und in wie vielen Fällen die Promotion durch die ägyptische Regierung und durch Selbstfinanzierung ermöglicht wurde.

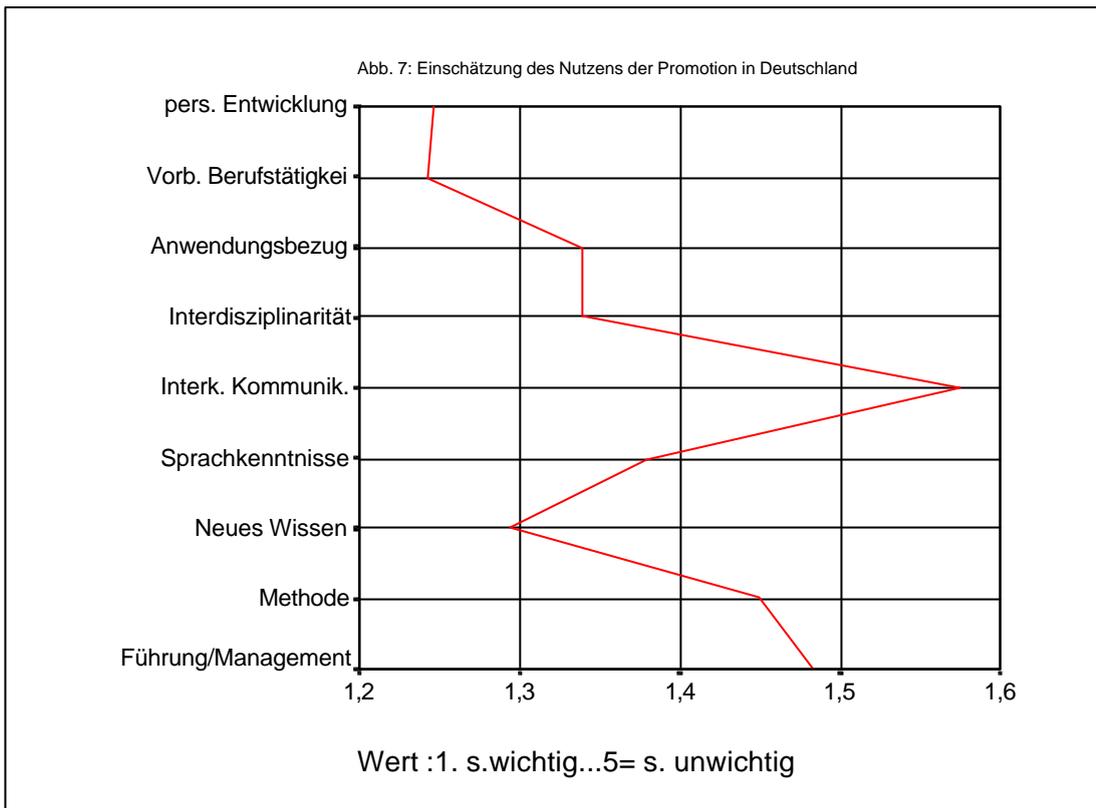
Die Dauer der Promotion in Deutschland ist in Abbildung 6 dargestellt. Es ist anzunehmen, dass es sich bei den angegebenen Promotionsdauern unter 2 Jahren um das Channel- oder das Sandwich-System handelt. Die durchschnittliche Promotionsdauer beträgt jedoch 3,85 Jahre bei einer Standardabweichung von 1,65 und einer Spanne von 1 bis 7 Jahren.



Immerhin liegen insgesamt 23 Fälle (35%) bei einer Promotionsdauer zwischen 5 und 6 Jahren, was eine lange Promotionszeit bedeutet.

In 20 Fällen (30,7%) hielten sich die Promotionskandidaten in Ägypten auf. Es ist anzunehmen, dass diese Zahl das Channel-System betrifft, während die restlichen 35 (ca. 54%) sich während der Promotion nicht in Ägypten aufhielten. In den meisten Fällen war der Aufenthalt 1 Monat im Jahr.

Die Vielfalt der Promotionsthemen ist im Anhang wiedergegeben.



## Einschätzung des Nutzens des Promotionsstudiums in Deutschland

Ähnlich wie im Falle des 1. Studiums wurde nach dem Nutzen des Promotionsstudiums in Deutschland gefragt (n=65). Mit den selben Kategorien (s. Abschnitt 6) gab es folgende aggregierte Abbildung. Das Ergebnis ist fast identisch mit dem Ergebnis beim 1. Studium mit dem Unterschied, dass hier durch die hohe Anzahl der Fälle die Aussagen gesicherter sind.

Ausgedrückt in Prozentzahlen ergibt sich bei der Beurteilung die folgende Tabelle.

Tab. 6: Prozentuale Verteilung der Beurteilung des Promotionsstudiums in Deutschland

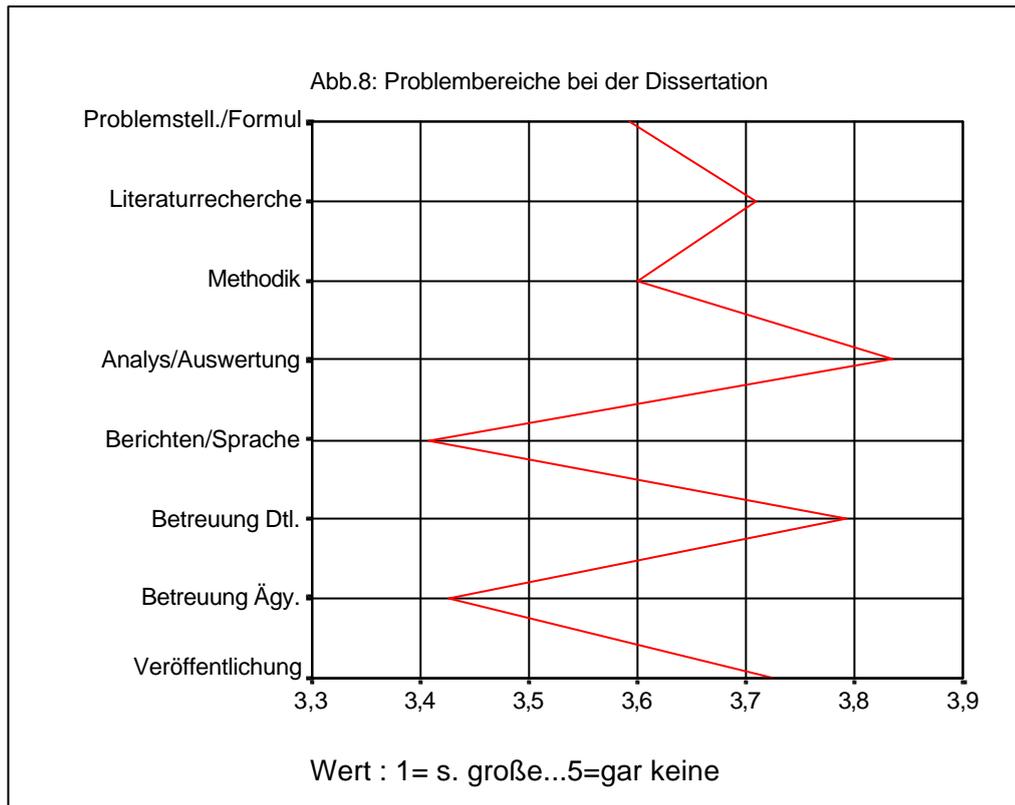
Bereich	s. wichtig	wichtig	indiff	e. unwi.
Pers. Entw.	78,9	17,5	3,5	-
Vorb. Beruf	81,0	15,5	1,7	1,7
Anwendung	71,4	25,0	1,8	1,8
Int. diszipl.	75,5	18,9	3,8	1,9
Int.kul.Komm.	61,1	24,1	13,0	1,9
Sprache	74,1	13,8	12,1	-
Neues Wissen	77,6	19,0	1,7	1,7
Methoden	77,6	13,8	1,7	6,9
Führ./T. Arb.	67,2	20,7	8,6	3,4

Auch hier fällt die äußerst positive Einschätzung des Promotionsstudiums bei sehr geringer Standardabweichung auf.

Die Frage nach den Problembereichen bei der Promotion bezogen sich auf die Problemstellung und Formulierung des Forschungsthemas, auf die Literaturrecherche, die Methode, die Analyse und Auswertung, die Betreuung in Deutschland und Ägypten sowie auf die Veröffentlichung.

Interessanter Weise lagen die Probleme im Durchschnitt in *kleineren Problembereichen*, die, wie aus Abbildung 8 zu entnehmen ist, im Intervallskalenbereich zwischen 3,4 und 3,9 lagen. Dennoch ist deutlich zu sehen, dass die Probleme bei dem Promotionsstudium hauptsächlich im Bereich der Sprache bzw. im Bereich der Berichterstattung und sprachlichen Abfassung der Dissertation und bei der Betreuung und Anleitung in Ägypten liegen. Auch kleinere Probleme liegen bei der Methode, bei der Problemstellung und Formulierung von Forschungsvorhaben sowie bei der Betreuung.

Der Weg zum Doktorvater in Deutschland ging in erster Linie über die Bekanntschaft der ägyptischen Betreuer/in mit dem deutschen Betreuer/in (42%) und über die Korrespondenz mit den deutschen Einrichtungen (Unis, DAAD, etc.) (45%), die den Doktorvater empfohlen haben.



In den anderen Fällen waren es Gespräche mit den Kollegen bzw. der ägyptischen Kulturabteilung in Bonn, die zum Doktorvater geführt haben.

In 44 Fällen haben die Befragten auf das Thema der Dissertation Einfluss genommen. In 10 Fällen konnten sie zum Teil Einfluss üben. 11 Fälle haben sich dazu nicht geäußert.

Allerdings ist in 19 Fällen eine Einflussnahme der ägyptischen Seite angegeben, was sich nicht mit der vorangegangenen Angaben auch dann nicht deckt, wenn man die Antwortverweigerer als Nichteinflussnehmende identifiziert. In 25 Fällen jedoch ist die Einflussnahme von der ägyptischen Seite angegeben. Eine teilweise Einflussnahme wird in 10 Fällen bestätigt.

Tab.7: Vorgaben für das Thema der Dissertation von ägyptischer Seite

		Häufigkeit	Prozent	Gültige Prozente	Kumulierte Prozente
Gültig	ja		29,2	35,2	35,2
	nein	25	38,5	46,3	81,5
	zum Teil	10	15,4	18,5	100
	Gesamt	54	83,1	100	
Fehlend	System	11	16,9		
Gesamt		65	100		

Tab. 8: Wissenschaftliche Beiträge auf der Basis der Dissertation

		Häufigkeit	Prozent	Gültige Prozente	Kumulierte Prozente
Gültig	nein	3	4,6	5,5	5,5
	ja, während der Dissertation	25	38,5	45,5	50,9
	ja, nach der Promotion	10	15,4	18,2	69,1
	ja, erst in Ägypten	4	6,2	7,3	76,4
	ja, während der Dissertation & nach der Promotion	8	12,3	14,5	90,9
	ja, nach der Promotion & erst in Ägypten	2	3,1	3,6	94,5
	ja, während der Dissertation & erst in Ägypten	1	1,5	1,8	96,4
	ja, während der Dissert. & nach der Promo. & erst in Ägypt.	2	3,1	3,6	100
	Gesamt	55	84,6	100	
Fehlend	System	10	15,4		
Gesamt		65	100		

## Das Promotionsverfahren

Es ist bei den ausländischen Studierenden üblich, dass vor der Aufnahme des Promotionsverfahrens in Deutschland bestimmte Vorleistungen zu erbringen sind. Diese sind vor allem der Nachweis der deutschen Sprachkenntnisse, das Nachholen bestimmter Fachprüfungen, das Anfertigen einer schriftlichen Arbeit in Form einer Diplom- oder Magisterarbeit.

In 44 Fällen (67,7 %) sind diese Vorleistungen in irgendeiner Form zu erbringen gewesen.

16,9 % brauchten keinerlei Vorleistungen zu erbringen. 15,4% machen hierzu keine Angaben.

In der folgenden Tabelle sind die Arten der Vorleistung dargestellt. Da nur in 44 Fällen die Vorleistungen zu erbringen gewesen sind, muß angenommen werden, dass in 17 Fällen mehr als eine der Vorleistungen zu erbringen waren. Der Spitzenreiter bei den Vorleistungen ist die Sprachprüfung gewesen, gefolgt vom Nachholen von bestimmten Fachprüfungen. In 7 Fällen mußte eine Diplomarbeit nachgeholt werden.

Tab.9: Erbrachte Vorleistungen beim Promotionsstudium

Art der Vorleistung	Häufigkeit	(%)
Sprachprüfung	34	55,75
Fachprüfung	20	32,79
Diplomarbeit	7	11,46
S	61	100

Die Befragten bekamen Hilfe und Unterstützung bei der Promotion von verschiedenen Stellen. In der folgenden Tabelle ist abzulesen, dass die Professoren und Assistenten bei der Hilfeleistung an der 1. bzw. 2. Stelle genannt werden. Die Hochschulen zeigen sich jedoch im Bereich der Hilfeleistung weniger an der untersten Stelle.

Nur sehr wenige haben Zusatzqualifikationen wie EDV-Kenntnisse, Teamarbeit und Präsentationstechniken erwerben können (in 2 Fällen EDV, in 5 Fällen Teamarbeit und in einem Fall Präsentationstechniken).

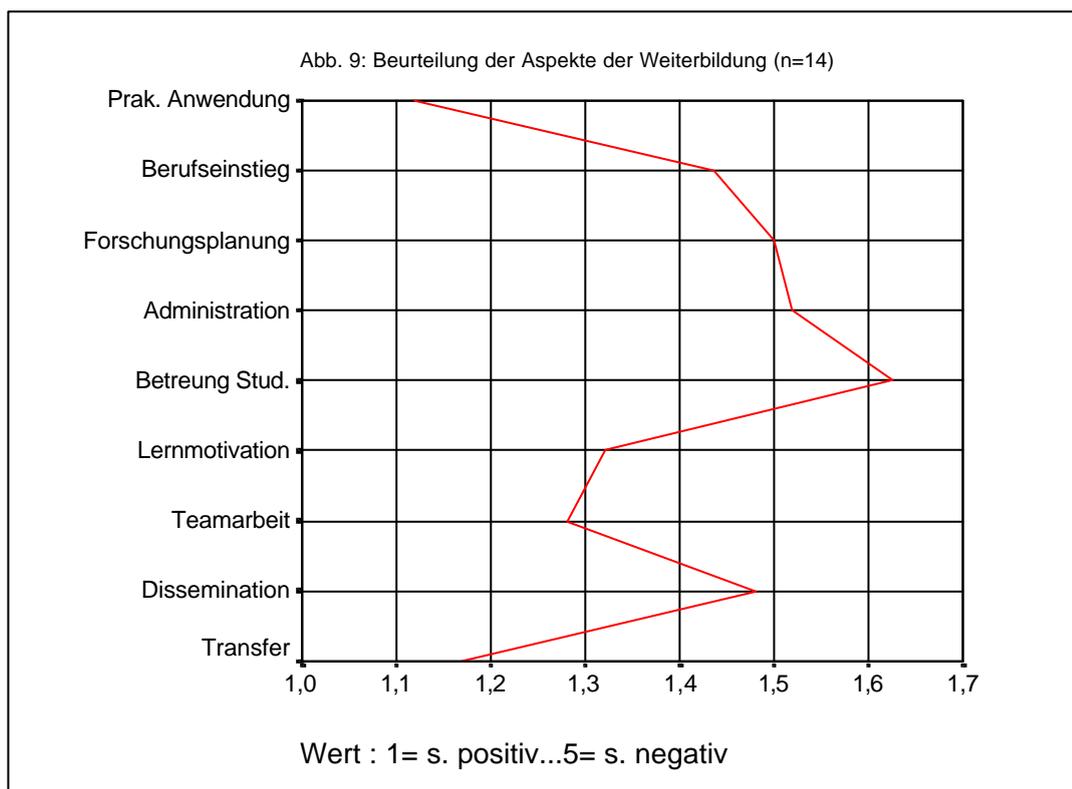
Tab. 10: Unterstützung bei der Promotion

Unterstützung durch	Ja	Nein	k. Angabe
Professoren	42	12	11
Assistenten	35	19	11
Hochschulen	16	39	10
Sonstige	24	31	10

In 8% der Fälle werden die Anerkennungsprobleme der in Deutschland erworbenen Promotionen in Ägypten angegeben. Allerdings handelt es dabei weniger um die Akkreditierungsprobleme, sondern eher um die bürokratischen Probleme und Probleme bei den ägyptischen Betreuern und den Berufseinstieg als Dozent in der Hochschule.

## Teilnahme an weiterbildenden Programmen

Unter den Befragten haben 12 an einem der 6-monatigen weiterbildenden Programme Hochschuldidaktik und Internationale Entwicklung an der Gesamthochschule Kassel-Witzenhausen teilgenommen. Diese Weiterbildungskurse waren zwischen 1973 und 1992 Bestandteil eines vom BMZ geförderten Reintegrationsprogramms mit dem Ziel, im Anschluß an das abgeschlossene Promotionsstudium auf den Arbeitsplatz Hochschule in der Heimat vorzubereiten. Die Inhalte waren Hochschuldidaktik (Lehre), Forschungsmanagement und Hochschuladministration.



Zwei der Befragten haben an einem der zweimonatigen „University Staff Development Programm“ in Witzenhausen teilgenommen, das mit den ähnlichen Inhalten seit 1994 eingerichtet ist und von DSE und DAAD gefördert wird.

Bei der Beurteilung der weiterbildenden Programme HD-Kurs und UNISTAFF wurden die praktische Anwendung im Beruf, Hilfe beim Berufseinstieg, Hilfe bei der Konzipierung und Planung von Forschungsvorhaben, Verbesserung der organisatorischen und administrativen

Fähigkeiten, Betreuung von Studierenden und Doktoranden, Förderung der Motivation beim Lernen und Studieren, Fähigkeit zur Zusammenarbeit mit Kolleginnen und Kollegen in der Hochschule, Vorbereitung und Durchführung von Konferenzen und Tagungen sowie Transfer von angeeigneten Kenntnissen im Hochschulbereich analog zu den Inhalten der weiterbildenden Maßnahmen als „Statements“ vorgegeben.

Im Durchschnitt liegen die Urteile im positiven Bereich einer Intervallskala von 1=sehr positiv bis 5=sehr negativ wie aus Abbildung 9 zu entnehmen ist. Besonders positiv fallen die praktische Anwendung und der Transfer von Kenntnissen im Hochschulbereich sowie die Teamarbeit aus.

Von 41 Befragten, die nicht an einem weiterbildenden Programm teilgenommen hatten, melden 32 einen Bedarf für ein weiterbildendes Angebot im Bereich der Lehre, Forschung und Hochschulorganisation. 11 von ihnen halten Praktika auf diesen Gebieten für förderlich.

## Die Beschäftigungssituation

Alle Befragten sind bis auf 3 als Vollzeitdozenten an ihren Universitäten beschäftigt. In einem Fall ist aufgrund einer Tätigkeit in Libyen und Saudi-Arabien für 10 Jahre die Einstellung an ägyptischen Universitäten problematisch geworden. In zwei Fällen wird eine Vollzeitarbeit an den Universitäten angestrebt. Bezüglich der Beschäftigungsart an den Universitäten wurden unterschiedliche Tätigkeiten aufgeführt, die in Detail im Anhang nachzulesen sind.

## Kontakte und Nachkontakte

In der Tabelle 11 ist die Zusammenarbeit mit den deutschen Institutionen dargestellt. Die Mehrzahl der Befragten (49%) hat keinerlei Zusammenarbeit mit den deutschen Institutionen.

35,4% der Befragten arbeiten in irgendeiner Art und Weise eine Zusammenarbeit mit den deutschen Einrichtungen zusammen.

Tab. 11: Zusammenarbeit mit Institutionen in Deutschland

		Häufigkeit	Prozent	Gültige Prozente	Kumulierte Prozente
Gültig	ja	23	35,4	41,8	41,8
	nein	32	49,2	58,2	100
	Gesamt	55	84,6	100	
Fehlend	System	10	15,4		
Gesamt		65	100		

Dabei handelt es sich hauptsächlich um höhere Altersgruppen zwischen 51 und 60 Jahren. Während die 41- bis 50-jährigen weniger eine Zusammenarbeit angeben. Diese Verbindung läßt sich mit Hilfe einer asymptotischen Signifikanz nachweisen (s. Tabelle unten)

Tab. 12: Zusammenarbeiten mit Institutionen in Deutschland in Zusammenhang mit dem Alter

Alter	ja	nein	Gesamt
bis 40	7	6	13
bis 50	6	21	27
bis 60	10	4	14
Darüber		1	1
Gesamt	23	32	55

## Chi-Quadrat-Tests

	Wert	df	Asymptotische Signifikanz (2-seitig)
Chi-Quadrat nach Pearson	10,798	3	0,013
Likelihood-Quotient	11,466	3	0,009
Zusammenhang linear-mit-linear	0,399	1	0,528
Anzahl der gültigen Fälle	55		

a 2 Zellen (25,0%) haben eine erwartete Häufigkeit kleiner 5. Die minimale erwartete Häufigkeit ist ,42.

Von 58 gültigen Fällen waren 44 (67,7%) in den letzten zwei Jahren nicht in Deutschland. Dabei handelt es sich wiederum, wie im vorigen Beispiel, um ältere Befragte. Eine weitere Analyse läßt die Aussage zu, dass in der Altersgruppe 41 bis 50 Jahre die meisten Promovierten mit Channel-System und Sandwich-System vertreten sind, was wiederum die Hypothese nahelegt, dass das Vollstudium eine stärkere Bindung zu Deutschland und eine intensivere Zusammenarbeit ermöglicht. Natürlich muß diese Hypothese noch überprüft werden.

Tab. 13: In den letzten 2 Jahren in Deutschland

		Häufigkeit	Prozent	Gültige Prozente	Kumulierte Prozente
Gültig	ja	14	21,5	24,1	24,1
	nein	44	67,7	75,9	100
	Gesamt	58	89,2	100	
Fehlend	System	7	10,8		
Gesamt		65	100		

Über die Jahre nach der Rückkehr in die Heimat geben 64,6% der Befragten Kontakte zu ihren Universitäten und Hochschulen in Deutschland an. Diese sind jedoch weniger wissenschaftlicher Austausch, sondern persönliche Kontakte zu den Professoren und Assistenten in Form von Glückwünschen und Postkarten zu Weihnachten und Neujahr.

49,2% der Befragten halten Kontakte zu ihren Stipendiengebern. Über die Art dieser Kontakte war keine nähere Information erhältlich. Nur 29,2% geben den Erhalt von Information von ihren früheren Stipendiengebern (hauptsächlich DAAD-Stipendiaten) an.

Angesichts der Tatsache, dass 94,7% der Befragten eine Bereitschaft zur aktiven Mitarbeit bei der Verbesserung der Kontakte zu Deutschland signalisieren, scheint die Maßnahme des DAAD bei der Förderung der Nachkontakte von besonderer Bedeutung zu sein.

Über die Art und Weise dieser Kontakte sind zahlreiche Vorschläge von den Befragten zu verzeichnen:

- Die Bildung von aktiven Gruppen von Forschern mit Beteiligung von deutschen und ägyptischen Wissenschaftler/innen
- Austausch von wissenschaftlichen Erkenntnissen zwischen den deutschen und ägyptischen Wissenschaftler/innen per e-mail, Internet und sonstige Medien wie „Newsletter“ usw.
- Veranstaltung von gemeinsamen Tagungen, Konferenzen und Veranstaltungen
- Gründung eines selbständigen gemeinsamen Büros mit Kontaktmöglichkeiten und einer Datenbank
- Organisatorische Hilfeleistung bei der Beschäftigung in der Heimat
- Förderung der Karriereplanung der ägyptischen Wissenschaftler/innen über Veröffentlichungen in Sonderausgaben
- Möglichkeiten der Teilnahme an internationalen wissenschaftlichen Tagungen

**Fragebogen (A 1 - A 3):**

**A 1: Fragebogen**

**A 2: Beschäftigungsart**

**A 3: Promotionsthemen**

**A 1: Fragebogen**

Persönliche Angaben

Name, Vorname			
Geburtsjahr			
Akad. Titel			
Dienstanschrift (Tel., FAX, e-mail)			
Akad. Abschlüsse	Ägypten	Deutschland	Sonstige Länder
	BSc/BA/Bvet MSc/Ma/Mvet PhD/Dr.	Diplom MSc Dr. Sonstiges (z.B. HD-Kurs, BV-Kurs)	

**Studienabschluß in Ägypten oder Drittland vor Aufnahme des Studiums in Deutschland**

Nein

Ja

	1. Studium	2. Studium
Studienfach		
Studienort		
Studiendauer (von-bis)		
Abschlussgrad		

3. Welche Gründe waren für Sie entscheidend, in Deutschland zu studieren?

4. Studienverlauf und Studienabschluß in Deutschland

Anmerkung: Falls Sie **mehrere** Studienabschlüsse haben, untenstehende Fragen bitte für jeden Studiengang getrennt beantworten

4.1 Hatten Sie Schwierigkeiten bei der Zulassung?

Ja  Nein

Wenn ja, welche?

4.2. Deutsche Sprachkurse (Institution, Ort, von-bis)

4.3. Erwerb eines Zertifikats

Ja  Nein

**Das erste in Deutschland abgeschlossene Studium**

Wenn Sie in Deutschland gleich mit dem Promotionsstudium begonnen haben, gehen Sie bitte direkt zu Frage 5f

4.4 Studiengang (z.B. Diplom-, Aufbaustudium)

4.5 Studienort / Hochschule / Institut

4.6 Studienfach

4.7 Schwerpunkt

4.8 Studium von - bis

4.9 Titel/Thematik/Bereich der Diplom-Magister-Promotionsarbeit.

4.10 Finanzierung des Studiums

**4.10.1 Hauptquelle:**

4.11 Einschätzung des Nutzens des Studiums in Deutschland (bitte Zutreffendes ankreuzen)

	Sehr wichtig	Eher wichtig	indifferent	Eher unwichtig	Ganz unwichtig
Persönliche Entwicklung-	0	0	0	0	0
Vorbereitung auf Berufstätigkeit	0	0	0	0	0
Anwendungsbezug	0	0	0	0	0
Interdisziplinäres Arbeiten	0	0	0	0	0
Interkulturelle Kommunikation	0	0	0	0	0
Sprachkenntnisse	0	0	0	0	0
Neues Wissen	0	0	0	0	0
Methoden und Arbeitsinstrumente	0	0	0	0	0
Führung, Teamarbeit, Management	0	0	0	0	0

4.12 Wie bewerten Sie aus heutiger Sicht bestimmte Aspekte Ihres Studiums in Deutschland? Bitte Zutreffendes ankreuzen

	Sehr wichtig	Eher wichtig	indifferent	Eher unwichtig	Ganz unwichtig
Beratung und Betreuung bei der	<input type="radio"/>				
Beratung und Betreuung bei der Magister/Diplomarbeit	<input type="radio"/>				
Breite des Studienangebots	<input type="radio"/>				
Möglichkeiten zur freien Gestaltung des Studiums	<input type="radio"/>				
Qualität der Vermittlung der Lehrinhalte	<input type="radio"/>				
Zugang zu Fachliteratur/Bibliothek	<input type="radio"/>				
Kontakte zu anderen Studierenden	<input type="radio"/>				
Möglichkeiten, am Rande des Studiums zusätzliche Qualifikationen zu erwerben	<input type="radio"/>				

5. Promotionsstudium

5.1 Studienort / Hochschule / Institut

5.2 Art des Promotionsstudiums (z.B. Channel, Sandwich usw.)

5.3 Schwerpunkt / Richtung

**5.4 Dauer des Promotionsstudiums (von - bis)**

**5.5 Titel/Thematik/Bereich der Dissertation**

5.6 Forschungsaufenthalt in Ägypten

ja

nein

Wenn ja, Dauer in Monaten:

Finanzierung durch:

5.7 Finanzierung des Promotionsstudiums

**5.7.1 Hauptquelle:**

5.7.2 Weitere Quellen:

**5.8 Einschätzung des Nutzens des Promotionsstudiums in Deutschland. Zutreffendes bitte ankreuzen**

	Sehr wichtig	Eher wichtig	indifferent	Eher unwichtig	Ganz unwichtig
Persönliche Entwicklung	<input type="radio"/>				
Vorbereitung auf Berufstätigkeit	<input type="radio"/>				
Anwendungsbezug	<input type="radio"/>				
Interdisziplinäres Arbeiten	<input type="radio"/>				
Interkulturelle Kommunikation	<input type="radio"/>				
Sprachkenntnisse	<input type="radio"/>				
Neues Wissen	<input type="radio"/>				
Methoden und Arbeitsinstrumente	<input type="radio"/>				
Führung, Teamarbeit, Management	<input type="radio"/>				

5.9 In welchem der folgenden Bereiche bei der Dissertation gab es Probleme? Zutreffendes bitte ankreuzen

	Sehr	große	indifferent	kleine	gar keine
Problemstellung / Formulierung des Forschungsthemas	<input type="radio"/>				
Literaturrecherche	<input type="radio"/>				
Methodik (einschl. Labor, Experimente, Analyse / Auswertung	<input type="radio"/>				
Berichterstattung	<input type="radio"/>				
Betreuung / Anleitung in Deutschland	<input type="radio"/>				
Betreuung / Anleitung in Ägypten	<input type="radio"/>				
Veröffentlichung	<input type="radio"/>				

5.10 Wie kamen Sie zu Ihrem Doktorvater?

5.11 Haben Sie auf das Thema Ihrer Dissertation Einfluss nehmen können?

Ja  Nein  zum Teil

5.12 Gab es Vorgaben für das Thema der Dissertation von ägyptischer Seite?

Ja  Nein  zum Teil

5.13 Konnten Sie auf der Basis Ihrer Dissertation irgendwelche wissenschaftlichen Beiträge veröffentlichen?

nein

ja, während der Dissertation

ja, nach der Promotion

ja, erst in Ägypten

**6. Promotionsverfahren**

6.1 Hatten Sie vor der Aufnahme des Promotionsstudiums irgendwelche Vorleistungen zu erbringen (z.B. Sprachprüfungen, Nachholen bestimmter Fachprüfungen, Anfertigung einer schriftlichen Arbeit - Diplomarbeit) usw.?

nein

ja, welche?

6.2 Von welcher Seite haben Sie bei der Promotion irgendwelche Hilfe und Unterstützung bekommen (Hochschule / Professoren / Assistenten / Sonstige)? Bitte nennen Sie die drei wichtigsten.

6.3 Konnten Sie während Ihres Promotionsstudiums in Deutschland zusätzliche Qualifikationen erwerben (z.B. EDV, Teamarbeit, Präsentationstechniken)?

nein

ja, welche?

6.4 Gab es Probleme bei der Anerkennung (Akkreditierung) Ihres Promotionsabschlusses in Ägypten?

nein

ja, welche (Art des Programms, Jahr Dauer)?

7. Haben Sie an Weiterbildungsprogrammen in Deutschland teilgenommen (z.B. Hochschuldidaktik-Kurs, UNISTAFF, BV-Kurs, Praktika usw.)?

nein

ja, welche (Art des Programms, Jahr Dauer)?

7.1 Falls Sie Frage 7 mit „ja“ beantwortet haben, wie beurteilen Sie diese Weiterbildung im Hinblick auf die folgenden Aspekte? Bitte Zutreffendes ankreuzen

Aspekt	++	+	+-	-	--
Praktische Anwendung im Beruf	<input type="radio"/>				
Hilfe beim Berufseinstieg	<input type="radio"/>				
Hilfe bei der Konzipierung und Planung von Forschungsarbeiten	<input type="radio"/>				
Verbesserung der organisatorischen und administrativen Fähigkeiten	<input type="radio"/>				
Betreuung von Studierenden / Doktoranden	<input type="radio"/>				
Förderung der Motivation beim Lernen und Studieren	<input type="radio"/>				
Fähigkeit zur Zusammenarbeit mit Kolleginnen und Kollegen in der Hochschule	<input type="radio"/>				
Vorbereitung und Durchführung von Konferenzen / Tagungen	<input type="radio"/>				
Transfer Ihrer Kenntnisse im Hochschulbereich	<input type="radio"/>				

7.2 Falls Sie an solchen Programmen nicht teilgenommen haben, besteht bei Ihnen der Bedarf für eine Teilnahme an einem der aufgeführten Bereiche?

nein

ja (falls ja, nennen Sie die drei wichtigsten)

8. Berufsverlauf nach dem Studium in Deutschland (kurze Beschreibung der Tätigkeiten nach Ort, Art und Dauer)

8.1 Nennen Sie die wichtigsten Veröffentlichungen nach der Aufnahme Ihrer Tätigkeit (Art der Veröffentlichung, z.B. Zeitschrift, Thematik, Jahr)

8.2 Waren Sie nach der Aufnahme Ihrer Tätigkeit im Ausland?

nein

ja (falls ja, wie oft und zu welchem Zweck)

**9. Jetzige Beschäftigungssituation**

9.1 Hauptbeschäftigung / Position in der Hochschule / Institut

9.1.1 Ort

9.1.2 Seit wann?

9.1.3 Art/Schwerpunkte/Bereiche

9.2 Nebenbeschäftigung

9.2.1 Ort

9.2.2 Seit wann?

9.2.3 Art/Schwerpunkte/Bereiche

9.3 Weitere Nebenbeschäftigungen

9.3.1 Ort

9.3.2 Seit wann?

9.3.3 Art/Schwerpunkte/Bereiche

**10. Kontakte - Nachkontakte**

10.1 Arbeiten Sie mit Institutionen in Deutschland zusammen (wenn ja, welche und wie?)

ja  nein

10.2 Waren Sie in den letzten 2 Jahren in Deutschland?

ja  nein

10.3 Stehen Sie noch in Kontakt mit Ihrer früheren Hochschule?

ja  nein

10.4 Haben Sie noch Kontakt zu Ihrer früheren Stipendienorganisation?

ja  nein

10.5 Sind Sie informiert über das Nachkontaktangebot Ihres früheren Stipendiengabers?

ja  nein

10.6 Sind Sie bereit, aktiv bei der Nachkontaktarbeit mitzumachen? Wenn ja, in welchem Bereich?

ja  nein

10.7 Ideen und Vorschläge zur Verbesserung der Nachkontaktarbeit / Networking

**A 2: Beschäftigung**

Hauptbeschäftigung / Position in der Hochschule / Institut

1	Abteilungsleiter: Tierproduktion, Landwirtschaftliche Fak., Minufuya Uni.
2	Assis. Prof., Pflanzenbereich, Landwirtsch. Fak., Menoufiya Uni.
3	Assis. Prof., Fac. of Agric., Tanta Uni.
4	Assis. Prof. (Biochemie), Menoufiya Uni.
5	Assis. Prof. in Milchhygiene, Fac. of Vet. Med., Assiut Uni., Ägypten
6	Assoc. Prof.
7	Assoc. Prof of Animal Medicine
8	Assoc. Prof.
10	Assoc. Prof. in Faculty of Agriculture
11	Assoc. Prof. in Fayoum, Landwirtsch. Fak.
12	Assoc. Prof. in Forensic Med. & Toxicology
13	Assoc. Prof. zur Forschung und Lehre der Kurse Pflanzenernährung und Bodenfruchtbarkeit
14	Assoc. Prof., Chemistry of Pesticides
15	Assoc. Prof., Mansoura Uni., Fac. of Agric.
16	Assoc. Prof., Pflanzenbau, Pflanzenzüchtung, Agronomy Dep., Fac. of Agric., Menoufiya Uni.
17	Assoc. Prof., Tanta Uni., Ägypten
18	Assoc. Prof., Vet. Med.; Direktor des Basic Vet. Med. Sci.; Dekan der Vet. Fak., Jordanien
19	Ausbildung für Studenten und Doktoranten; als Prof. in der Abteilung der Lebensmitteltech., Agrarwirtsch. Fakultät, Assiut Uni.
20	Bodenkunde (Chemie und Biochemie), Assoc. Prof., Abt. Bodenkunde, Tanta Uni.
21	Chairman of Dep. of animal med. and infections and fish diseases, Fac. of vet. med., Sadat City, Menoufiya Uni.
22	Consultant
23	Direktor der Pflanzenschutzabteilung (92 - 94); Vizedekan für Hochschulstudenten (94 - 99); ab Aug. 99 bin ich pensioniert
24	Dozent
25	Dozent an der Fak. für Landwirtsch. der Uni. Mansoura
26	Fac. Vet. Med., Alex. Uni., Assoc. Prof. Dr., Milk Hygiene
27	Head of Dep. of Anatomy and Embrology, Faculty of Vet. Med., Zagazig Uni.
28	Ing. in Nile Water Sector
29	Lecturer in Mansoura Uni.
30	Lecturer of Animal Hygiene, Fac. of Vet. Med., Suez Canal Uni.
31	Lecturer, PhD, Suez canal uni., fac. of agric., Ani. prod. dep.
32	Lehrer, Abt. Entomologie und Pestizide, Landwirtsch. Fak., Kairo Uni.
33	Ordentlicher Prof.
34	Prof.
35	Prof. an der botanischen Abt. der Landwirtsch. Fak. der Uni. Menoufiya
36	Prof. Chemistry of Pesticides
37	Prof. Dr.
38	Prof. Dr. an der Landwirtsch. Fak., Kairo Uni., Abt. der Pestiziden

39	Prof. Dr. an der Menoufiya Uni., Agrar Fak., Agrarwirtschaftabt.
40	Prof. Dr. für Heil- und Gewürzpflanzen, Zierpflanzen und Gartenanlegen, Kairo Uni., Gartenbau Inst.
41	Prof. Dr. in Mansoura Uni.
42	Prof. Dr. in Mansoura Uni., Horticulture Dep.
43	Prof. Dr. in Pesticide Dep., Fac. of Agric., Cairo Uni.
44	Prof. Dr., Innermedizin
45	Prof. für Genetik, Agricultural Botany Dep., Fac. of Agric., Zagazig Uni.
46	Prof. für Lebensmittel- und Verfahrenstechnik (Agrarproduktion)
47	Prof. für vet. Chirurgie in Zagazig Uni.
48	Prof. in Bodenkunde (Wissenschaft)
49	Prof. in Fac. of Agric., Agr. Eng. Dep., Kairo Uni.
50	Prof. of Agr. Fac. of Agric., Pflanzenbau Dep., Zagazig Uni.
51	Quantität und Qualität von Wasser in Nilfluss. Nilwassersektor - Ministry of Public Works and Water Resources
52	Seit mehr als 1 Jahr Omar El Mokhtar Uni. verlassen, weil es dort keine echte Forschung gibt. Ich möchte gerne in Ägypten arbeiten. Aber ich finde keine Arbeit
53	Senior researcher in Animal Health Research Inst.
54	Teaching and Research as Assoc. Prof. in Ain Shams Uni.
55	Vollprof. an der Agronomy Dep., Faculty of Agriculture Kafr El Sheikh, Tanta Uni.
56	Vollprof. an der Pflanzenschutzabt., Zagazig Uni.

### A 3: Promotionsthemen in Deutschland

Titel / Thematik / Bereich der Dissertation (Promotionsstudium in Deutschland)

55	Abbau von aromatischen Verbindungen durch Actinomyceten
43	Aflatoxins residues in feedlot cattle farms in Assiut governorate
54	Assessment of the hygienic quality of some dairy products
23	Bakteriologie und Immunologie, Adhäsionseigenschaften von <i>P. Multolida</i>
16	Comparative studies of some treatments on the viability and fertilizing ability of sheep and goat spermatozoa
11	Controlled release pesticide for controlling of Watersnails
30	Die Probleme der Getreideversorgung in Ägypten in den Jahren 1980 – 1990
10	Die Wirkungen der Pestizide auf die Bioaktivität des Bodens
13	Direkte und indirekte Immunoperoxidase-Technik zum Nachweis von Antikörpern gegen Hundstaupe, Masern, Rinderpest und Seehundstaupe-Viren
47	Effect of potassium and water supply on dry matter production of grapes
17	Effekt der N-Inhibitoren auf Weizenkörner, Pflanzenproduktion
52	Effekt von Pflanzentermin, Pflanzenmaterial und CCC Behandlung auf die Entwicklung und den Ertrag von Erdbeeren
48	Eigenschaften der Böden in der Region Schalma (Nord-Nil-Delta, Ägypten)
34	Einfluss der Tierernährung im Praepartum auf die Wechselwirkung im Postpartum
12	Einfluss der Kohlenhydrateversorgung auf Stickstoff Rumino-hepatischen Kreislauf und mikrobielle Versorgung im Pansen der Wiederkäuer
19	Einfluss von Kationen auf Enzymaktivität und Synthetase
5	Einfluss von Nitrifiziden, mineralische Stickstoffdüngung auf Stickstoffaufnahme mit Kulturpflanzen Gerste, Weizen und Mais im Salzboden
9	Einfluss von ökologischen und ontogenetischen Faktoren auf Anbau und Zusammensetzung der ätherischen Öle von <i>Chenopodium Ambiosiedes</i>
7	Einfluss von Phytohormones auf das Austreiben und Bewurzelung der Kaffeepflanzen
50	Endoskopie bei Pferden mit Lungenerkrankungen (COPD)
58	Energy metabolism in fish under different management systems
24	Entwässerungsbedarf und -fähigkeit von schluffreichen Brackmarschböden, untersucht in Modell- und langjährigen Feldversuchen
1	Entwicklung der Nebenniere des Schafes
49	Evaporation, Klimadiagramme und ihre Bedeutung in der Beurteilung des Wasserhaushaltes in verschiedenen Klimazonen
39	Experimentale Hyperschildddrüse beim Hund
26	Extraktive Verfahren zur Verbesserung der Zitrusindustrie in Ägypten

33	Fertilization and pruning on peach
59	Genetic studies on some qualitative characters in broad bean
27	Grünflächensituation in den ägyptischen Städten und die Möglichkeiten zur Verbesserung der Grünversorgung, dargestellt am Beispiel des Grossraums Kairo
44	Increase of the efficiency of Baculo viruses and a comparative study of an Egyptian isolate
40	Intensivierung der Winterproduktion von Tomaten in Unterägypten
29	Inter – Intraspezifische Konkurrenz zwischen vier Blauläusearten
4	Isolierung und Charakterisierung von Pentosanfraktionen aus verschiedenen Weizensorten, Lebensmitteltech., Getreidetechn.
36	Mastitis
25	Optimum protein energy ration and protein level in the ration of Tilapia niloticus (oreochromis niloticus) in intensive culture
45	Osteochondrosis dissicans am Talobunval-Gelenk des Pferdes
32	Phytopharmakologische Untersuchungen mit der Grünalge Chlorella Fusca: Der Bleichvorgang mit Metflurazon und die Regeneration zu einem neuen Zelltyp
62	Pseudomonas aerogenosa cytotoxin
	Relationship between claw affections and metabolic disturbances in dairy cattle
14	Sanitary studies on newly born calves, Bacteriological studies on neonatal calf diarrhoea among newly born buffalo calves in Egypt with special regard to Enteropathogenic (EPEC) and Enterohaemorrhagic E. coli (EHEC)
64	Selection for salinity tolerance and Fusarium resistance within anther culture derived potato clones
3	Selektion von resistenten Mutanten von Gerste gegen Mehltau (Erysiphe graminis f. sp. hordei)
6	Serum Tryptophanbestimmung beim Rind. Die Beziehung dieser Aminosäure zum Zyklusgeschehen
56	Sister chromatid exchanges in Xiphophorus before and after treatment with N - methyl N - nitroso - ureal
57	Studies on reproduction physiological aspects in rabbits
65	Thermodynamic behavior of the building construction of an intensity ventilated barn under Egyptian conditions - Environmental Control & Farm Building
41	Toxicological studies on the effect of the heavy metals (Hg, Cd and Pb) on the Acridida Aiolopus thalassinus (Fabr.)
20	Untersuchung des Endometriums während des postpartalen Zeitraums beim Schaf
22	Untersuchung über Kältetoleranz und Überwinterung, Synanthroper Fliegen, Vorratsschutz, angewandte Entomologie
18	Untersuchungen des Vorkommens und der Bedeutung von Clostridium perfringens beim Schwein in Nordwestdeutschland
35	Untersuchungen über die optimale Wasserversorgung von Zuckerrüben durch Beregnung und deren Einfluss auf Wachstum und Nährstoffgehalt
38	Untersuchungen zur Genetik der Weizenspeicherproteine und ihrer Beziehung zur Backqualität
63	Untersuchungen zur züchterischen Verbesserung der Siliereignung von einjährigem Weidelgras im Stoppelsaatenbau
21	Wechselwirkungen zwischen Hubiziden, Huminstoffen und Tonmineralen im Dreikomponentensystem
28	Wurzelentwicklung von Weizen unter N - Düngung und Bodentiefe
15	Zur Kenntnis der mikrobiellen Keratinabbauprodukte und deren physiologische Wirkungen