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Challenges to Organic Farming and Sustainable Land Use in the Tropics and Subtropics

Rainer Georg Joergensen ^{*1}

Keywords: organic farming, sustainable agriculture, tropics, subtropics

The central aim of Organic Farming is to maintain and improve soil fertility as a means of supporting animal health by species-adapted animal keeping and feeding. These two aims have developed from the basic desire of many human beings to live in harmony with nature, ultimately emanating from a wish to sustain their own health.

In industrialised countries of temperate humid climate, diseases of modern civilisation have been developing at an alarming rate. One of the main reasons is excessive and incorrect nutrition, resulting from alienation in preparing and making our own foodstuffs. In this respect, food procurement today looks at qualitative aspects, i.e. at changes in nutritional habits, especially at a reduction of excessive meat consumption, but also at taking precautionary action to ensure that foodstuffs are free of pathogenic agents and harmful substances. In many tropical and subtropical regions, man is not supplied with sufficient amounts of food. In this context food procurement means protection against hunger and help in the daily fight for survival. This means that the main focus is on quantitative aspects of food production. However, the risks of intensive farming also have a completely different magnitude in tropical and subtropical regions due to the much more frequent occurrence of acute poisoning after the improper use of pesticides (CASTILLO, X., 2000).

Organic Farming tries to meet the demands of man in temperate humid as well as in tropical and subtropical regions and to provide something of a unifying element. The tension between these different demands and the resulting exciting discussion is a specific feature of our faculty "Ecological Agricultural Sciences" in Witzenhausen, with its strong roots in both Sustainable Tropical and Subtropical Agriculture and in Organic Farming.

In the view of a soil biologist, who tends to consider the aspects of soil fertility, the basic principles of Organic Farming mainly rely on the efficient and careful use of natural resources in all climatic regions (PAOLETTI, M.C. *et al.*, 1993; LAVELLE, P. *et al.*, 1999). Under temperate humid climatic conditions, Organic Farming is especially devoted to protection against environmental pollution. Under tropical and subtropical climates, the possibilities of human intervention are enormously restricted due to the environmental conditions, e.g. nutrient deficiency of many soils or the drought of the climate, even if sufficient mineral fertilizers were available (PRASAD, R. and POWER,

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J.F., 1997). A characteristic feature of Organic Farming is the attempt to integrate problems into a systematic approach, to resist the temptation of simple solutions in mono-causal reason-effect-relationships, e.g. in finding a soil biological reference number that gives a fertilizer recommendation with a constant value. The euphoria in the use of molecular biological methods in the area of gene technology generates the suspicion that scientists search with complex methods for apparently simple solutions. This leads to the expectation that crop yields can be miraculously increased, for example, by introducing and switching on a gene. Problems are dealt with by taking immediate action, leading to fast and furious campaigns. Tackling problems in a systematic way, often called a holistic approach, entails the inherent risk that a specific topic will be dealt with very superficially.

It is a major problem that the transfer of knowledge from temperate humid to tropical/subtropical regions is impossible or seriously restricted. The use of easily-soluble mineral P-fertilizers is not really useful in P-fixing soils regularly occurring in large areas of tropical and subtropical regions (CASTILLO, X., 2000). Through promotion of soil microorganisms, e.g. by suitable soil organic matter management, P is much better held in biological cycles. However, knowledge about the control mechanisms of biological processes in tropical and subtropical soil is very sparse, especially considering the observation that the composition of the microbial decomposer community differs enormously in tropical and subtropical soils from those in humid temperate regions (REES, R.M. *et al.*, 1999).

Not only is available knowledge regarding the large diversity of the tropical and subtropical regions restricted, but the realization of the farmers themselves is also hampered by quite different problems to those experienced in industrialised temperate humid regions. The cultural and political conditions, for instance with regard to property rights and the level of education, mean that the transfer of scientific knowledge can often only take place within very close limits (BOLANOS, M.F., 2000). While the profession of a farmer requires an academic education in some countries of the European Union, land-using persons in tropical and subtropical regions are often very poorly educated, often lacking the most basic reading and writing skills. This problem is becoming increasingly serious with the increasing disappearance of rural traditions.

A special advantage of Organic Farming is the fact that it always takes the social and political environment of human beings into consideration and not only the production of foodstuffs. Even more important for the development of sustainable agriculture in the tropics and the subtropics is the future oriented character of Organic Farming. In setting itself current limits in the means of production, its outlook into the future is unlimited.

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Beyond Land Titling for Sustainable Management of Agricultural Land: Lessons from Ndome and Ghazi in Taita-Taveta, Kenya

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Abstract

This paper is based on a 1996-1999 case study that was done in semi-arid Ndome and Ghazi, Taita-Taveta District, in Kenya to determine the root causes of persistent erosion damage in the area. More than 10 years after land adjudication was done in these areas, more than 70% of the farmers still operate under tenure insecurity mainly due to lack of title deeds ($r = 0.94^{**}$). Contrary to conventional expectation of land development, owning of land under private property rights was motivated by the sense of belonging, wealth, power and to some degree for speculative purposes. Adoption of structural soil and water conservation measures was still well below 50%. Preference was still given to indigenous land and water management (ILWM) technologies, with adoption rates ranging from 60% to more than 90%. No evidence existed that directly linked land improvement to land titling. For sustainable land management, land titling remains a critical incentive to farmers. However it will have to be accompanied by land use policy reforms that address four main issues, thus: deliberate efforts to preserve agricultural land, equitable distribution of available land, putting as much land as possible to agricultural use, and mechanisms to enhance prevention and control of land degradation. How these objectives can be achieved within the Kenyan context is the conceptual gist of this paper.

Keywords: Land Titling, Sustainable Land Management, Policies, Kenya

1 Introduction

In this paper, sustainable land management encompasses use, care and improvement of the land resource with the deliberate aim of guaranteeing inter and intra-generation equity in terms of food security, essential land products and other services. Three main designations of land tenure are distinguished in Kenya: government (public) land tenure, customary (communal, traditional) land tenure, and private land tenure (titling) (PANDER, 1995). Since pre-independence, conservation policies in the country have regularly included a call for land titling as a prerequisite for conservation and effective land development. This has been based on the assumption that assured ownership of

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the land determines the degree and extent of tapping on the products and/or benefits from it, and hence peoples' propensity to invest capital in land improvement on a sustainable basis (JUMA and OJWANG, 1996; WACHTER, 1996; GTZ, 1998; LINIGER *et al.*, 1998). The process has been rather slow and skewed with the ASAL areas being neglected under the notion of adverse climatic conditions, economic constraints and political insignificance (DE GROST *et al.*, 1992; ONDIEGE, 1996).

State ownership and management of natural resources like land is generally justified on the assumption that it would bring about equity considerations or collective societal interests in common pool resources (MURPHREE, 1993). The contrary is more true in Kenya where government land tenure has been associated with widespread inequity in distribution of land, destruction of natural forests and catchment areas, and loss of prime land to infrastructure development (INSTITUTE OF ECONOMIC AFFAIRS, 1998). Communal land tenure tends on the other hand to be associated with ecological collapse in the absence of regulatory mechanisms regarding the resource, when scarcity drives competition and the struggle to survive among the resource users (SIDA, 1993). As an aspect of agrarian law, land titling vests legal ownership and tapping of all benefits accrued from the land to individuals and at the absolute discretion of the legal owner (OCHIENG and OMINDE, 1993). Owners and land often have no ecological links. Land is a disposable commodity, whose ownership is a sign of wealth and power and hence livelihood security.

Consequently, land titling has become a major determinant of socio-economic and political development in Kenya. With increasing land scarcity and high risks of conflicts, communal tenure is slowly but surely being replaced with private tenure. GALATY (1992) observed that already some 40% of individual group ranches in Maasai land have been sold to individuals, who in turn use such lands for speculation and collateral rather than for dry-land development. By putting a lot of emphasis on ownership, which is often ascribed based on political influence, access and use rights that would otherwise be enjoyed by many other potentially productive people are disregarded. This in part explains the widespread skewed land distribution, land idleness, landlessness, land conflicts and artificial land shortages in Kenya, which together undermine agricultural productivity, environmental conservation and overall economic development of the country (INSTITUTE OF ECONOMIC AFFAIRS, 1998). According to OKOTH-OGENDO (1998), less than 10% of large farms in Kenya are productive, while the rest remain idle, mainly for speculative purposes.

The Zimbabwe case, where 1% of farmers own nearly 50% of available agricultural land and the bulk of the fertile land (ADAMS *et al.*, 1999), is a typical current example of the long term socio-economic and political implications of inequity in land distribution. A similar situation is true for South Africa largely due to procrastinated land reforms as depicted in the following quote by Tshepo Khumbane (SPORE, 2001): "The truth is, the past of "New" South Africa is still very much alive. It has to do with people's access to land and their hopes that land is the key to breaking the poverty cycle."

The volatility and hostility of land issues in Kenya can be traced to colonial and immediate post-colonial period, when greed, tribal factors and elitism dictated ownership,

access and use of land (MORTON, 1998). This trend has continued to the present making land issues extremely sensitive, and with that accessing land data generally impossible. Issues of land ownership and land use have acquired a central place in the media, public policy and political discourse in the country. Suffice is to say that land ownership remains perhaps one of the oldest problems in agricultural and political development in Kenya, with potential for serious socio-economic and political repercussions. This in part explains the lack of political will towards radical policy adjustments for the survival of the country. Current efforts though in this endeavour include the Njonjo land commission and the constitution of Kenya review commission (CKRC), which are yet to complete their tasks.

From a global perspective, inequities in ownership, access and use of natural resources particularly land for agriculturally dependent countries will serve only to promote domestic poverty. This will in turn enhance the out-migration of desperate people to “greener pasture countries”. The socio-economic and political consequences of such economic and ecological refugees are starting to bite in the “favoured” recipient countries as exemplified by media reports on racial and sectarian intolerance and the growing importance of right wing political ideologies.

2 Methodology

By virtue of the study’s diagnostic nature, interactive questionnaire surveys were used to solicit answers and responses from 129 households in Ndome that were randomly selected from village development committee records. For Ghazi, three topical Participatory Rural Appraisals (PRAs) covering villages regarded as most affected by the erosion damage were used to gather data from mixed groups mobilised by the village development committees. Key respondents within the community were engaged for data verification. Additional secondary data was gathered from the ministry of agriculture. Ndome and Ghazi are located in Ngolia location next to Voi town in Taita Taveta District, coast province, in Kenya.

3 Results and Discussion

More than 10 years after the process of adjudication was initiated (1984), more than 70% of farmers interviewed still felt insecure on their farms. Of the three identified causes of land tenure insecurity, lack of title deeds was significant ($r = 0.94^{**}$) and accounted for 65% relatively. The risk of losing farmland due to unavoidable ecological factors accounted for 22% of the insecurity. Though not significant, the rather high percentage was indicative of the extent of farmland losses incurred during the 1996-97 El-Nino rains. Culturally driven insecurity with $r = 0.25^{**}$ was indicative of the vulnerability of women headed households in terms of land ownership as catalysed by deep-rooted gender forces (Table 1).

Insecurity of tenure was also in part a serious disincentive to the use of fertilisers and structural conservation measures for land improvement ($r = -0.18^*$ and -0.19^*) respectively. This could be attributed to the inherent tendency of land users to invest capital, labour and time where direct benefits in the shortest time possible are guaranteed. That

Table 1: Relationship between selected land variable and land tenure insecurity

Land related variable	Percentage household response	r of variables in relationship to tenure insecurity
Tenure insecurity	72	1
Reasons for tenure insecurity		
No title deed	73 (65)	0.94**
Ecological disaster	25 (22)	0.13
Gender biases	14 (13)	0.25**
Soil and water conservation measures practised		
Physical structural	25 (8)	-0.19*
Grass strips	81 (25)	-0.05
Indigenous land and water management	98 (31)	0.02
Tree planting	28 (9)	-0.06
Farm Yard Manure	76 (24)	0.04
Fertiliser application	9 (3)	-0.18*
Conflicts and policy dimension		
Presence of land conflicts	72	0.126
Extent of soil and water conservation under conflicts	33	-0.097
Continuation of land use under conflicts	80	0.023
Tax Land	20	0.13
Tax idle land	58	0.22*
Tax land that lacks in necessary conservation measures	70	0.03

** : The correlation is significant at C.I of 0.01; * : The correlation is significant at C.I of 0.05. Figures in brackets are weighted values against 100%.

only about 20% of households were in favour of some kind of land tax as a management tool was indicative of peoples' lack of serious commitment to the land resource as a critical life-support system. With taxation only significant with respect to idle land ($r = 0.22^*$) as opposed to neglect of conservation ($r = 0.03$), resource use and access to its benefits comes first from a local perspective. Conservation on the other hand assumes second thoughts, as it must be prioritised against other pressing household needs.

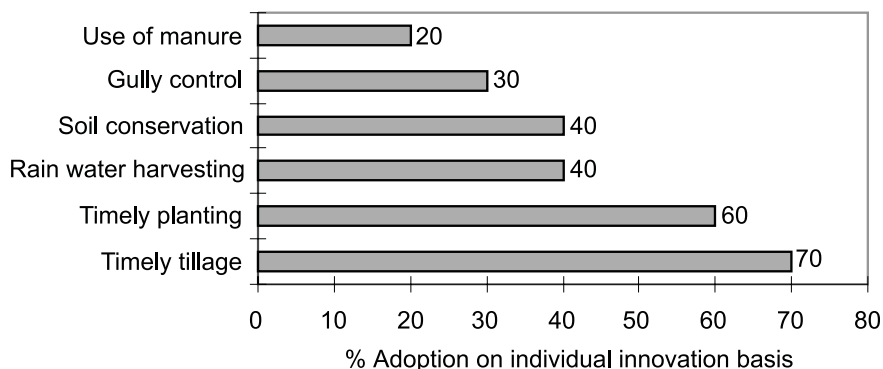
The positive correlation between tenure insecurity and land taxation however indicated that people would wish to own land but not be accountable to it in anyway. This explains why much land in Kenya is owned for speculative purposes with subsequent high levels of artificial land shortages and poverty. Therefore who should own land, how much and for what purpose are important policy issues in Kenya today.

One of the immediate effects of land titling was proliferation of land conflicts, which involved more than 70% of the households. The main cause of conflicts was the emerging

restrictions on open access tendencies on grazing fields. Although titling policy allowed land users to register as many undisputed plots as one had, only land parcels in the proximity of the homestead were used for routine cropping. The remaining scattered plots were normally left idle and lend themselves to vegetative and physical degradation through communal open-grazing practices, thus defeating the real purpose of titling. That 80% of the households continued to use disputed land, while only 33% continued with conservation measures on disputed land at the same time, signalled potentially severe degradation in the long run.

Further, contrary to conventional expectation, land titling did not attract any loans for land improvement from credit institutions. This was attributed to the inherently low quality of land and hence the uncertainty on the part of credit institutions of the farmers' abilities to payback. Land users' on the other hand lacked interest for the same due to fears of losing their land in case of default. Looked at from a location and district level, there was no direct evidence linking land titling to enhanced land improvement. Estimates of overall soil and water conservation impact in the district showed that only 10% of the farms were well conserved, 50% were partially conserved while the remaining 40% had no single conservation structures in place. Where structures existed, 90% received no routine maintenance (PRA TEAM, 1998), (Figures 1 and 2).

Figure 1: Estimated adoption rates of specific soil and water conservation measures in Taita-Taveta District (REPUBLIC OF KENYA, 1997)



The apparent below average adoption of structural soil and water conservation measures was due to the high costs and labour requirements. Maintenance of structural conservation works was mainly hindered by the persistent destruction of the same to be expected during the routine off-season grazing. This explains why farmers put emphasis on indigenous land and water management (ILWM) technologies such as timely planting, timely tillage, use of manure, mixed cropping and inter-cropping. However, though cost effective, ILWM technologies alone will not be able to adjust to the increasing pressure on land and concurrent higher demand for food commensurate with growing human population.

The smallness of the relationships discussed above indicated that other factors were more important than titling alone in land management endeavours (Figure 3).

Figure 2: Relative importance of soil and water conservation practises in Ndome-Ghazi; N=129; ILWM = Indigenous land and water management. (Source: Own survey, 1998)

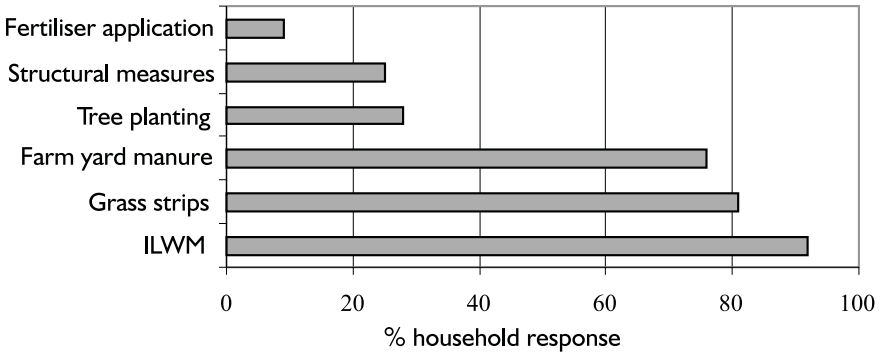
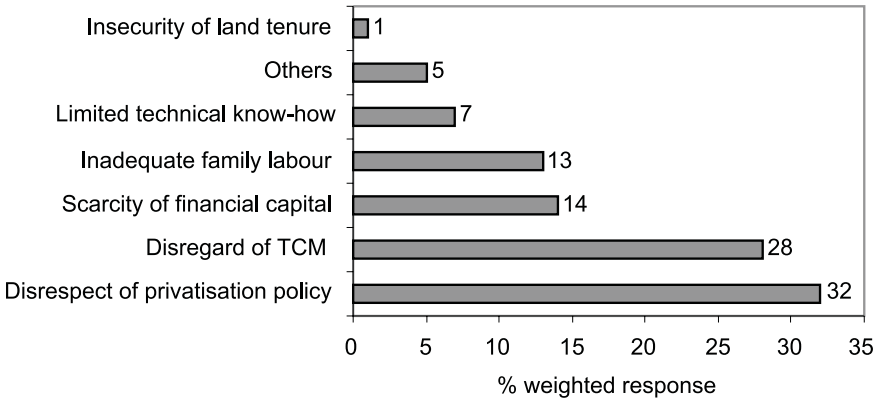


Figure 3: Relative importance of soil and water conservation practises in Ndome-Ghazi; N=129; ILWM = Indigenous land and water management. (Source: Own survey, 1998)



Key among them were:

- Widespread failure on the part of the community to respect the titling policy, with subsequent enhancement of vegetative degradation through persistent open grazing practices;
- Lack of consistent teamwork among farmers and hence inability to effectively benefit from total catchment management approaches;
- Inadequate family labour attributed to massive out-migration of men in such of off-farm jobs in urban centres; and
- Scarcity of financial capital for investment in land management attributed to high poverty levels in the community.

4 Conclusions and Recommendations

In view of the socio-economic and political development trends in Kenya, the importance of land in guaranteeing people's livelihoods, and the increasing scarcity of arable land, ownership of land under private property rights remains the single most important factor that guarantees land tenure security. Owning land for speculative purposes is however preferred to harnessing land for improved agricultural development. Since poverty, farming and land tenure are closely related in Kenya, attainment of sustainable land management will necessitate land tenure policies that would help alleviate poverty countrywide. To this end, land titling policy will have to enhance the realisation of four main objectives:

- Deliberate efforts to preserve/save available agricultural land,
- Putting as much land as possible to agricultural use,
- Deliberate efforts towards equitable re-distribution of available land, and
- Effective approaches and strategies to control degradation of agricultural land in-situ.

These broad objectives would require among others the following tenure reform policies perceived as those requiring urgent attention in Kenya, thus:

- As a rule of thumb, priority for the use of prime land should be food production, given the importance of food security in economic and ecological development of the country. Any other alternative use of such land, must be pegged on its relative contribution to the above objective,
- Regional and countrywide routine land inventories and quality monitoring systems to facilitate timeliness in degradation control,
- Establishment of legally binding ownership and sub-division ceilings to enhance equity in ownership, access and use of available land. Apart from annulling the ecological, socio-economic and political consequences of artificial land shortages, increased production possibilities would be steps towards food security and hence sustainable development of the nation.
- Regulation of rural land settlement patterns in favour of cluster-linear systems to promote catchment-based runoff management, facilitate rural infrastructure development and delivery of services, and also to preserve land for agricultural purposes,
- Mechanisms to regulate the excesses of private property rights, particularly when the profit motives undermine the common good. Controlled land transactions would for instance help protect family land from unauthorised sales by the legal owner, guarantee access to land and its products by all family members, minimise land conflicts and hence boost conservation farming,
- Establishment of conservation based criteria as determinants of the economic value of land. This would lessen the premium attached to "empty" parcels of land and hence accompanying negative effects such as land grabbing and conflicts.

- Establishment of effective taxation policies to curb the widespread tendencies of having idle land for speculative purposes.
- There is serious need for effective institutions and structures for the implementation and monitoring of such land management policies.

Although such land tenure reform policies would be certainly expensive in the short-term, the socio-economic, political and environmental benefits in the long-term should encourage the mastering of the required political will for their implementation. As a start, all stakeholders, with the government as a central player, should be willing and ready to enter into mutually beneficial negotiations.

Zusammenfassung

Dieser Beitrag basiert auf einer Fallstudie von 1996-1999 im semi-ariden Ndiemo und Ghazi, Taita-Taveta Distrikt in Kenia, die das Ziel hatte, die Ursachen der anhaltenden Erosionsschäden in der Region zu erforschen. Mehr als 10 Jahre nach der Landzuteilung leiden noch immer 70 % der Farmer in diesem Gebiet unter Unsicherheiten hinsichtlich ihres Landbesitzes, weil die Besitzurkunden (Landtitel) fehlen. Im Gegensatz zu herkömmlichen Entwicklungserwartungen war Landbesitz unter Privateigentum motiviert durch Zugehörigkeitsgefühl, Wohlstand, Macht und einem gewissen Grad an spekulativen Absichten. Die Anwendung geeigneter Massnahmen, um Boden und Wasser zu erhalten, lag immer noch deutlich unter 50%. Bevorzugt wurden zu 60 bis mehr als 90 % ortsübliche Land- und Wassermanagement-Technologien (ILWM). Offensichtlich existiert kein direkter Zusammenhang zwischen Landtiteln und verbesserten Landmanagement-Praktiken. Für die Farmer bleiben Landtitel ein kritischer Anreiz, um das Land nachhaltig zu bewirtschaften. Dennoch sind hierfür begleitende Reformbestimmungen zur Landnutzung nötig, die vier Hauptforderungen beinhalten: zielgerichtete Anstrengungen zur Erhaltung landwirtschaftlicher Flächen; gerechte Zuteilung der verfügbaren Flächen; Ausweitung der landwirtschaftlichen Nutzung; und verbesserte Mechanismen zur Vorsorge und Kontrolle der Landdegradierung. Wie diese Ziele im kenianischen Kontext erreicht werden können ist Kern dieses Beitrags.

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Counter Urbanization and Agricultural Input Productivity in Imo State of Nigeria

Dr. C.J. Arene*¹ and Mr. M. Mkpado¹

Abstract

This study analyzed the productivity of agricultural inputs in the context of counter-urbanization, a consequence of Nigeria's fiscal policy reform, in Okigwe Local Government Area (L.G.A) of Imo State, Nigeria. Sixty counter-urbanities who settled for farming were randomly selected from four autonomous communities in the L. G. A for the study. Sources of primary data were structured questionnaires, market survey, interviews and observation of farm activities. Descriptive statistics, multiple regression and gross margin analyses were tools employed in data analysis.

Results show that counter-urbanization has accelerated agricultural intensification and cultivation of marginal lands. Population density is significant and inversely related to output, while farm size, fertilizer application and fallow length were directly related to output. Labour and cropping density have not significantly affected output. The marginal values of the variable inputs were measures of their efficiency usage. The average farm size, and output per hectare are less than those of non-migrants recorded six years ago. Major sources of farmland were leasing and borrowing as opposed to inheritance. The study recommended among others provision of credit facilities for non-farm sectors to reduce the number of return migrants engaged in farming.

Keywords: counter-urbanization, agriculture, input productivity, Nigeria

1 Introduction

The movement of people from regions of higher concentration to regions of lower concentration or the movement of people from 'urban cities' to 'rural areas' is termed Counter-Urbanization, Return Migration, or Urban-Rural Migration (BERRY, 1976; CHAMPION, 1989). It could be seen as government policy to achieve equitable distribution of population, reduction of urban unemployment and alleviation of poverty. This is mostly recognized when government creates incentives that attract people to rural areas (PAUL, 1992). Nigeria as one of the developing countries of Sub-Saharan Africa had depended on agriculture as a major source of food products, raw materials as well as earning foreign exchange. These needs were met by mainly subsistence farmers who made up to 85 percent of the population before the oil boom when agriculture contributed up to 80 percent of the country's total export (EKANONE, 1993). Agriculture at that time was

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characterized by scarce capital inputs high labour supply, abundant land and simple tools (OSUGIRI, 1996). All those who can put up with its labour demand enjoyed lucrative and extensive production.

The discovery of crude petroleum and its boom led Nigerians to misplace priority to the detriment of agriculture as there was massive importation of food products and raw materials which subsistence farmers have been producing. Nigerians' taste favoured imported agricultural products which started competing effectively with local alternatives. Consequently, there was no market for the local agricultural products. Rural-urban migration ensued, and urban population and unemployment increased dramatically.

The disappearance of the oil boom syndrome made it difficult for the country to maintain high-level importation of food to feed the rapidly growing population (SOLUDO, 1995). To halt the increasing debt that government is incurring in its efforts to satisfy the consumption pattern which had been developed during the oil boom era, the structural adjustment programme (SAP) was launched in 1986. The implementation of SAP affected the socio-economic, technological and ecological environment of the country. For instance, the massive retrenchment of workers - a fiscal policy measure aimed at reducing the labour force in the formal sector - as well as government reluctance to increase wages to match the inflationary trend resulted in poverty becoming the hallmark of the economy. Consequently, to avoid being crushed by the receding economy, counter-urbanization process began.

Counter urbanization increases agricultural intensification and reduces input productivity in areas of limited land space and traditional farm practices. Undue population pressure on limited arable land adversely affects its resource base and reduces input productivity because agricultural intensification without adequate soil management and conservation techniques can lead to low input productivity (BOSERUP, 1965; UDO, 1975; OKAFOR, 1982). Increasing food production to keep pace with its demand while retaining the quality of ecological balance of production systems is a major challenge to agricultural researchers and policy makers. Efforts made by this category of personnel to achieve the above objectives in Imo state have not been successful (OSUGIRI, 1996). Perhaps, this is due to the poor state of the economy or limited land available for agricultural production and problems of high population density as well as that of the land tenure system. Analysis along this direction have been limited to a series of disputable generalization without consistent objective support and this constitute a barrier to quick decision making (ARENE, 1996).

Increased food production is better pursued with intensification options accompanied by appropriate soil conservation techniques because land is a fixed factor of production. The study of indirect effects of the fiscal policy reforms on agricultural resource base of the economy is more pronounced when concentration is put on counter-urbanites who settled for farming. In view of the foregoing, this study aimed at describing the indicators of counter-urbanization and agricultural production systems in Okigwe Local Government Area (L. G. A) of Imo state in Nigeria. It further analyzed the productivity of these indicators and computed the trend in profitability of agricultural production in the area within the reform period.

2 Methodology

2.1 The Study Area

The study was conducted in Okigwe L. G. A of Imo State, Nigeria. Okigwe L.G.A lies between latitude 5.45 North and Longitude 7.15 East. Okigwe L. G. A has a land mass of 326km² and total population of 93,911 (NPC-FOS, 2000). The choice of the area is based on its high population density which has resulted in land pressure (OSUGIRI, 1996).

2.2 Sampling Procedure and Data Collection

A two-staged random sampling technique without replacement was used. First was the selection of four autonomous rural communities namely: Ezinachi, Ogi, Umulolo and Umuwaibu, based on their high population densities. Second was the random selection of fifteen counter-urbanites who settled for farming from each of the four autonomous communities giving a total of sixty farmer respondents.

Data were collected from both primary and secondary sources; primary data were obtained by the use of structured questionnaires on a random survey among the return migrants. Oral interviews, observations of farm activities and a market survey were conducted. These took place between July and October 2000. Information collected includes reasons for return migration, farmland acquisition, farm practices, cropping pattern, prices and other personal data. Secondary data were collected from relevant literature, reports, published and unpublished materials available in relevant ministries and libraries.

2.3 Analytical Techniques

Descriptive statistics, multiple regression, and gross margin analysis were tools employed in data analysis.

The null hypothesis that there is no significant effect of counter-urbanization indicators on agricultural productivity was tested using multiple regressions whose explicit form is given below:

$$Y = a + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + b_6 \log X_6 + e$$

Where:

Y = agricultural output in kg

X_1 = population density (No of persons per square kilometer)

X_2 = farm size (in hectares)

X_3 = cropping density (No of crops-stand per hectare)

X_4 = cultivation intensity (length of fallow periods in years)

X_5 = labour used (in man days)

X_6 = fertilizer application (dummy variable, 1 for use; else 0)

a = intercept

b_i = elasticity of response of the X_i th variable factors

e = stochastic error term with Ordinary Least Square (OLS) properties

Gross margin per hectare was used to estimate the trend in the profitability of agricultural production in the area using the results from Osugiri study in 1996 and the present study. Gross margin(GM) per hectare is given as:

$$\text{Gross margin}(GM) = \frac{\text{Total Revenue}(TR) - \text{Total variable}(TV) \text{ (all in Naira)}}{\text{Farm Size}(FS) \text{ (in hectares)}}$$

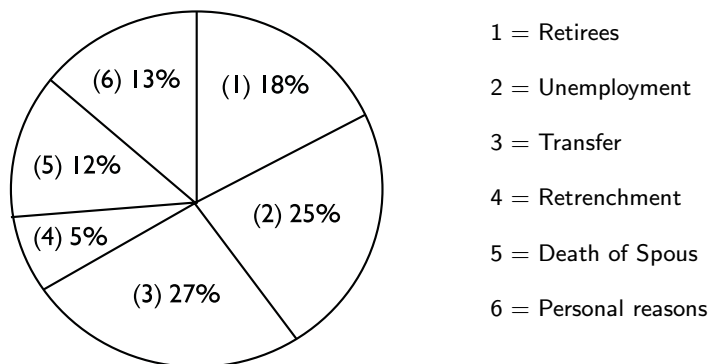
The revenue items include quantity of crops sold, quantity consumed and quantity given away, while the variable cost items include hired labour, fertilizers, pesticides and planting materials.

3 Results and Discussion

3.1 Descriptive Statistic Results

The survey indicated that 18 percent of the counter-urbanites were retirees, 25 percent were unemployed, 27 percent were on transfer, 5 percent were retrenched, death of spouse caused 12 percent to return and 13 percent held their reasons confidential. This supports the fact that SAP as well as government effort to cushion it are the major causes of counter-urbanization. The reasons for their return are illustrated in figure 1.

Figure 1: A Pie chart showing the percentage distribution of respondents according to their reasons for urban-to-rural migration.

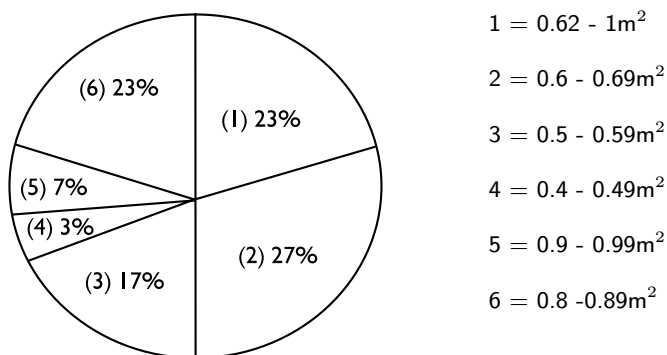


Source: Field Data 2000

This study also ascertains that communal land ownership where land is jointly owned by the community and allotted to members according to needs is not practiced. The present land tenure arrangement allows for family and individual ownership. Under family ownership, group of families having one ancestral lineage can own land called "compound land" or "family land". This group of land is usually the largest plot and is not frequently divided among families but is commonly used by family members, systematically. Individual land ownership is a result of families dividing their land among the male members. Such division is usually practiced within 20-30 years during which, females are not given any title to land. This leads to land fragmentation which poses problems to farm mechanization. It has been demonstrated by OSUGIRI (1996) that 93.3 percent of average rural dwellers in Imo state has access to farmland through

inheritance, while 3.558ha and 2.263ha represent their average land holding and farm size, respectively. This survey shows that only 30 percent of the counter-urbanites have access to land through inheritance, while 1.975ha and 1.4ha represent their average land holding and farm size respectively. The average planting distance of cassava in a mixture of cassava/maize inter-crop is 1m by 0.62m which gives a cropping density of 16,129 plants per hectare. This is less than the recommended density and it did not significantly affect productivity (fig. 2). It was demonstrated that increasing cropping density up to the recommended density has significantly decreased crop output in the area even at one percent probability level (OSUGIRI, 1996).

Figure 2: A pie chart illustrating the distribution of respondents according to their estimated planting distance of cassava in cassava/maize inter-crop.



Source: Field Data, 2000

The study found that 4.7 percent of the counter-urbanites operate on farm land with fallow length of 2-2.5 years while 52 percent allow 3-3.5 years of fallow, and 42 percent allow 4-4.5 years of fallow. An important aspect of integrated soil management techniques is the joint application of organic and inorganic fertilizers. The organic manure helps to replace the quantity lost from the bush fallow system due to slash and burn. The organic manure is necessary to buffer the Cation Exchange Capacity (CEC) of the soil and it reduces loss of nutrients by leaching. It also releases its nutrients gradually over time due to its carbon-nitrogen (C/N) ratio. The average quantity of organic and inorganic fertilizers used by farmers in this survey is 216kg and 37.5kg respectively while, the average quantity of inorganic fertilizer used in 1996, according to Osugiri study, was 27.92g. This study found that such practice has positively and significantly affected output. Intensive farming is accompanied by high labour inputs. Man-days of labour used in Okigwe and other parts of Imo State varies from 6-7 hours. The study found that marginal labour productivity is almost zero. This may be due to cultivation intensity in limited land space causing reduction in soil fertility. Low labour productivity may also be attributed to other factors such as attack of pests and diseases, erosion problems as well as lack of adequate fertilizer application. The average man-days of labour used per hectare in 1996 and 2000 are 65 and 86 respectively.

3.2 Regression Analysis Results

The regression Analysis Results show that:

$$Y = 331900 - \ln 593.05X_1 + \ln 12779X_2 + \ln 579.3X_3 + \ln 4350.7X_4 + \ln 878.53X_5 + \ln 1427.1X_6$$

$SE = (190070)$	(34.325)	(1927.4)	(936.61)	(2520.6)	(1214.6)	(790.04)
$t = (1.746)^*$	$(1.728)^*$	$(6.638)^{**}$	(0.619)	$(1.726)^*$	(0.723)	(1.806)

$F = 11.84^{**}$, $R^2 = 67$, $df = 59$

$SE =$ standard error, $t=t$ -statistics, $df=$ degree of freedom

** and * = statistically significant at 1% and 10% probability levels, respectively

Source: computed from field survey 2000

The regression results revealed population density is inversely related to agricultural output, while farm size, fertilizer-use and cultivation intensity have a direct effect. Cropping density and labour-use account for less. The results, therefore, indicate the need for increased cultivation intensity and fertilizer-use as such measure could in turn, increase labour productivity in the face of possible future land constraints emanating from worsening human/land ratios.

3.3 Gross Margin Analysis Result

An output of 9700kg of crops with a gross margin per hectare of N23,520.00 was reported by OSUGIRI (1996). This study revealed an output of 9376kg with a gross margin per hectare of N21,339.00, indicating a decreasing trend in profitability of agricultural production resulting from increasing production costs in the area.

4 Conclusion and Recommendations for Policy

The cropping pattern prevalent in the area is inter-cropping of cassava and maize. The average yield per hectare of crops is 9376.7kg against 9700kg recorded in 1996. The major sources of land holdings to counter-urbanites are pledging and borrowing and these often lack security of tenure. Gross Margin analysis shows that farming is still profitable in the area even though the marginal productivity of labour is almost zero. Independent variables such as population density, farm size, fertilizer-use and cultivation intensity significantly affected output in the area.

The findings and results showed that increased pressure on land has resulted in agricultural intensification and reduction in output. Consequently, the following recommendations are made:

- (1) Government should stop embarking on such policies that could result in counter-urbanization, and should rather engage in investments aimed at generating gainful employment for urbanites;
- (2) The provision of credit facilities to bonafide beneficiaries in rural areas should be encouraged so that more individuals could be self employed in other sectors of the rural economy rather than subsisting on farming alone.

- (3) Government should provide incentives geared towards providing markets in the rural areas, such that investment in farm and non-farm sectors will be lucrative as this will motivate the majority who do not have access to enough farm land to engage fully in non-farm economic activities, while those who have such access will continue farming. This is a possible diversification strategy for the rural economy.
- (4) Agricultural Development Programmes (ADPs) should intensify their extension activities focussing on encouraging farmers to adopt sustainable agricultural practices aimed at environmental conservation and higher input productivity.

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Adoptability Of New Technology In The Small-Holdings Tea Sector In The Low Country Of Sri Lanka

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Abstract

The degree of adoption of recommended technology is a crucial factor in the tea small-holdings sector of the low country Sri Lanka as far as the yield is concerned. An empirical study was carried out to ascertain the present situation. Almost all the recommendations were grouped into 11 packages (selection of clones, fertilizer application, soil and moisture conservation, field establishment, training, infilling, weed control, pruning, shading, pest and disease control and plucking). A package consisted of sub indicators to reveal farmers' adoption level. High, middle, low and non-adopters were given justified scores (according to their importance to the yield). The total of marks given to sub indicators was the adoption index of farmers. Though the mean adoption level was 71%, some packages such as pest and disease control, and weed control were marginally adopted. Highest adopted packages included plucking, clone selection, field establishment, and fertilizer application (above 75% level). Adoption level was positively correlated to education, number of dependents, labour use pattern, and subsidies and further, it was negatively correlated to land extent.

Key words: adoption, correlation, packages, sub indicators, tea

1 Introduction

The per cent share of agriculture in the Sri Lankan Gross Domestic Product (GDP) was 15.5% (CENTRAL BANK, 2001). The tea sector contributed 2.2% to GDP in total and earned Rs. 61,602 million (US\$ 690 million) from export products in 2001 (CENTRAL BANK, 2001). The total registered area under tea in 2001 was approximately 180,000 ha, of which 48% of extent was under small holdings and moreover, out of the total tea production, 62% comes from the small holding sector (CENTRAL BANK, 2001).

Ownership of tea cultivation in Sri Lanka is divided into three sectors viz. state holdings, large scale private holdings and small holdings. Up country tea estates are mostly state owned and well organized compared with low country plantations. The national average tea yield is around 1,786 kg per ha. This is well below the average yield of competing countries. As an example, the average yield of India is around 2,000 kg per ha (CENTRAL BANK, 2001). However, average yield of the smallholder sector was 2,212 kg per ha but in contrast, average yield for estate sector was only 1786 kg per ha.

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Annually a considerable sum of money is spent on tea research to undertake the process of technology generation. Based on such efforts, recommendations were developed and disseminated to the clients. However, the extent of adoption of these recommendations were a crucial issue. It seems that large tea estates have a positive adoption trend. But tea small holders' condition is not that clear. As large tea estates have an organized structure and necessary funds, they seem to be in a position to adopt new technologies. Although the extension services are functional, small holders' condition is not that comfortable to absorb new technology without incentives, because most of them are marginal farmers. BARUAH *et al.* (1998) have studied the relationship between technology gap and six socio-economic variables. Results indicate a 19.97%-48.07% technology gap among the majority of tea growers. Further, educational qualifications and mass media exposure had a significant negative relationship with technology gap.

Most innovations which are available to farmers for adoption into their production operations are the results of organized research and development. They originate mainly from research conducted by universities and by public or private research organizations. Agricultural extension, by which technology is transferred, is an activity and a process which may be termed "communication", since "the key role of communication, in any form, is to plant new ideas in the minds of men" (LEAGANS, 1963). M-LMWERE (1997) demonstrated that development of the tea smallholding sector can be achieved through intensive transfer of technology through extension, granting attention to in-filling, provision of fertilizer credit facility, supply of vegetative propagated materials, etc.

Knowledge on cultural practices, their attitudes and behavioral pattern, infrastructural facilities, nature of the land ownership, irrigation methods, financial and credit facilities, economic conditions of farmers and the degree of use of new technology are the major factors varied from farmer to farmer. Among these, technology and extension services are the most prominent determinants of the productivity (HERDT and CAPULE, 1983). In a Kanyan study, results elucidate that technological innovations with close research-extension-farmer linkages, timely availability of credit to purchase inputs, sound mechanisms for loan recovery, guaranteed output market, etc provide success stories (NOOR and BRETH, 1995). Moreover, even with present technology, extension strategies have to be oriented to rational use of inputs, and extension efforts have deal with infilling, replanting and replacement planting (HAZARIKA and SUBRAMANIAN, 1999).

The objectives of this study were to find out, the degree of farmers' adoption level, how they can be grouped into different adopter categories and to build up relationships between farmers, adoption level and independent variables such as age, education, land extent, etc.

2 Methods

Three small rural villages (Millawa, Aninkanda and Waralla) in Matara district (low country) of Sri Lanka were selected for the investigation and a sample of 90 farmers was drawn randomly. A field survey was conducted and the data were collected primarily by using a questionnaire. First, all the available agronomic practices (recommended by the Tea Research Institute, Sri Lanka) were divided into 11 main packages (clone

selection, field establishment, infilling, training (bush/plant), pruning, shading, plucking, fertilizer application, soil and moisture conservation, weed control, and pest and disease control). Then a justified weight was given to each package according to its importance to yield. In fact, the correlation between the different technical packages and yield was an assumption made on the technical competencies. Table 1 presents the weight allocation for each technical package and their contribution to adoption index. A main package consisted of several sub indicators. A sub indicator was the primary indicator of the adaptability of a specific practice. For each sub indicator farmers were given scores, according to his adoption level; high, middle, low and none. A farmer who practices the correct recommendation falls into the high adopter category and is given full marks. Deviators by 25% fall into middle adopter category whereas deviators by 50 % fall into low adopter category. The rest were non adopters and were given zero marks.

Table 1: Technical packages, allocation of weights and contribution to adoption index

	Technical Package	Weight (%)	Contribution to adoption index as a percentage
1	Selection of clones	100	13.8
2	Fertilizer application	93	12.8
3	Soil and moisture conservation	88	12.1
4	Field Establishment	75	10.3
5	Training (bush/plant)	65	8.9
6	Infilling	60	8.3
7	Weed control	58	8.0
8	Pruning	54	7.4
9	Shading	49	6.7
10	Pest and disease control	44	6.1
11	Plucking	41	5.6
	Total	727	100

3 Rationale for allocation of weights

The tea plantation started with seedling tea. Now newly selected clones are recommended and these clones, unlike seedling tea, surely give higher yields. The most striking way of increasing yields per acre is to replant with selected clonal tea (SIVAPALN, 1986). So the highest score of 100 marks was given to the selection of clones. When essential elements like Nitrogen, Phosphorous, Potassium are removed with tea yield, unlike other packages, these elements must be supplied by artificial fertilizers. Otherwise yield tends to drop drastically. Works on nitrogen, phosphorus and potassium fertilizer applications, done by many scientists have extensively demonstrated their importance on yield (MEHTA *et al.*, 1974; MARVAH *et al.*, 1977). So this package was valued 2nd most important and therefore 2nd highest score of 93 was given to it.

Apart from clones and fertilizers soil and moisture conservation is a critical factor in tea culture. Sustainability of both tea culture and macro environment largely depends on it. So it was ranked 3rd and the next highest score of 88 was assigned to it. Field establishment too is another important factor. It included spacing, planting hole dimensions etc. Once established a plant these parameters can never be changed. One has to do it correctly at the initial stage. So it was ranked 4th. The total marks of all the sub indicators were 75.

Training too has to be done correctly at early stages of the plant and if it is incorrectly done, it will affect the yield and income throughout the life span of the tea plant. Therefore, it was ranked 5th. The total marks of all the sub indicators were 65. Infilling has a great impact on yield. An important way of increasing productivity of a tea land is to adopt a properly worked out infilling programme (SIVAPALN, 1986). Less plants per acre, will give less yield. On the other hand, vacant areas will enhance weed growth and pest attacks. Infilling was ranked 6th. The total marks of all the sub indicators were 60.

Weed control is also important. Profusing weed growth competes with the tea plant for soil moisture and nutrients. They smother tea plant and promote pest population. It was ranked 7th. The total score was 58. Pruning has to be done from time to time. If it is not done at the correct time and to the correct method the plant starts deterioration. In fact, pruning in tea science can be regarded as a surgical operation in medicine. Tea bushes should be periodically pruned in order to maintain height, to stimulate vegetative growth and to maintain the frame of the bush (PETHIYAGODA, 1972; TUBBS, 1943; EDEN, 1958). Under Sri Lankan condition, shortage of skilled labour for pruning has become a limitation. Hence, tea Research Institute, Sri Lanka has introduced a motorized machine and a research results indicate a six-fold increase in labour output (WIJERATNE, 2001). It was ranked 8th. The total score was 54.

In low country areas two climatic factors; sunlight and temperature are considered too hard for the tea plant. Therefore shading is recognized as an important practice. The planting of shade trees and the maintenance of proper watershed is absolutely important for minimizing the drought effect of tea (SIVAPALN, 1986). So it was ranked at the 9th place. The total score was 49. Pest and disease control is not that important, especially in the low country, compared with the other practices. In a way it does not seem to bother tea cultivators. It was ranked 10th. The total score of the all sub indicators was 44. Plucking is a less important practice, compared with other practices. Therefore, it was ranked 11. The total score was 41.

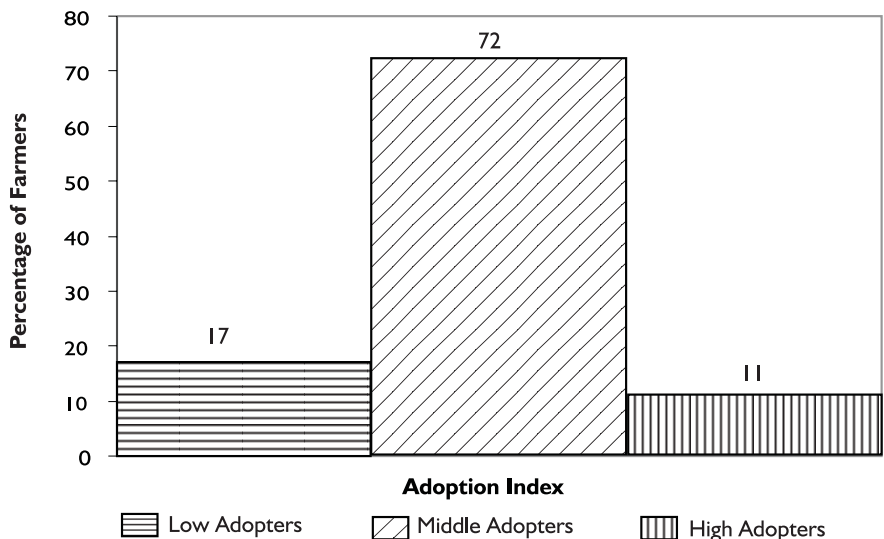
A farmer gets scores for recommendations in a technical package, according to the adoption level; high, middle, low, and none. The total of marks obtained by a farmer for all 11 packages indicates farmers' position in the adoption index. The adoption level of technical packages was calculated by averaging all marks obtained by farmers for a particular package.

A multiple regression analysis was done using the computer package SAS to determine the relationship between the adoption index and selected independent variables. Adopter categorization was done according to the standard adopter categorization procedure (ROGERS, 1983).

4 Results and Discussion

The mean adoption level in the research area was 71%. Adopter categorization is illustrated in Figure 1. Majority or 83% of farmers were in the middle and high adopter categories. This indicates that their adoption level was at a satisfactory stage. Such achievement may be attributed to the government extension service, which was functioning well. A similar study carried out in the paddy sector by WIJERATNE (1988) revealed that there were 26% innovators, 60% middle adopters and 14% late adopters. Table 2 demonstrates the mean adoption levels of technical packages.

Figure 1: Adopter Categorization



X = 518, SD = 57

Plucking is done at least once a week. It is a regular practice and the farmers adopt the correct expertise through practice. The higher level of adoption of packages such as clone selection, field establishment and fertilizer application could be attributed to the favorable extension service, high price received for farmer produce, and nature of regular income generation. A low adoption level was visible in the packages such as infilling, shading, training, pruning, soil and moisture conservation and weeding. The impact of these practices on the yield is not visible in the short run. Therefore, farmers concentrate more on other packages, which they think are more important. However it is important to grant attention to soil and moisture conservation throughout the life

Table 2: Mean adoption levels of the technical packages

	Technical package	Mean adoption level as a percentage
1	Plucking	98
2	Selection of clones	90
3	Field establishment	83
4	Fertilizer application	77
5	Infilling	71
6	Shading	68
7	Training	65
8	Pruning	60
9	Soil and moisture conservation	60
10	Weeding	59
11	Pest and disease control	38

span of tea plant. HASSELO and SIKURAJAPATHY (1965) estimated that during a four year period of replanting 251 tones/ha of soil is lost due to erosion, as a result of poor soil and moisture conservation practices.

Pest and disease outbreaks are rare in low country. Hence, farmers merely neglect to practice control measures. On the other hand, farmers are reluctantly to apply precautionary techniques, as cost of production is high. However, it was recommended that precautionary measures should be taken against live wood termites, shot hole borer and blister blight in low country holdings (TEA RESEARCH INSTITUTE, 1986).

The study attempted to establish relationship between adoption index and selected variables by employing the regression analysis. Table 3 illustrates the results.

The results reveal that more educated farmers corresponded to a higher adoption index. Educated farmers understand innovations easily. Farmers with more dependents correspond to a higher adoption index. When farmers have more dependents they have to work more. On the other hand, when there are more personnel to work in their fields, more labour can be employed on farm practices.

Land extent has shown a negative relationship. Farmers with smaller holdings had a higher adoption index, because smaller holdings may be intensively managed. Subsidies had a positive effect. When farmers are given subsidies they tend to invest on farm practices. When more labour is employed on their fields' farmers adopt innovations more. This is quite understood, as more labour can intensify the work.

5 Conclusions

The technology dissemination in the Sri Lankan tea small holding sector is at a satisfactory stage. The mean adoption level of 71% reflects this. Further, this was supported by the fact that a majority or 83% of farmers fall into high and middle adopter categories. But tea smallholders merely neglect some important recommendations; pest and disease control and weed control for instances. Though, soil and moisture conserva-

Table 3: Relationship between adoption index and selected variables

Variable	Coefficient	Std. Error	t - value	Probability (2-tail)
Constant	403.952	19.649	20.558	0.000
Age	0.164	0.245	0.667	0.507
Education	5.204	1.778	2.926	0.004
Dependents	5.772	2.318	2.490	0.015
Land extent	-14.433	4.554	-3.169	0.002
Subsidies	43.744	8.480	5.158	0.000
Labour/acre	1.908	0.492	3.878	0.000

$$R^2 = 0.622$$

tion is one of the most important disciplines in tea cultivation, it was paid a moderate attention. As the long term sustainability of this sector depends largely on soil and moisture conservation, farmers should be encouraged to practice correct conservation measures. Simple practices like mulching of inter-rows with *Cymbopogon confertiflorus* (mana grass), *Tripsicum laxum* (guatemala), *Eragrostis curvula*, etc. should be promoted. Mana grass and *Eragrostis* serve as effective mulching material (SANDANAM *et al.*, 1976).

Some packages like plucking, clone selection, field establishment, etc. are adopted at a higher level. By enhancing the adaptability of other packages especially marginally adopted ones, the productivity and income level of farmers can be improved. But some supporting services like transport system, government subsidy schemes and crop insurance schemes should be initiated to achieve this task.

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Perspectivas del Sector Cooperativo de Frutas y Hortalizas de la Unión Europea en el Contexto del Nuevo Modelo Europeo de Agricultura

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Abstract

In recent years, the fulfillment of trade agreements, such as The Uruguay Round, and the acceptance of competitiveness and multifunctionality in basic issues of agricultural development as a supplier of other kind of goods related with the environment, both have implied the dismantling of agricultural protection systems that altered free competitiveness in international markets.

Also, European people are becoming more aware of organic products and “Integrated Production Systems” ensuring agricultural practices which are more respectful with the environment. The accomplishment and guarantee of such a group of agricultural practices might underlie protection mechanisms that use food safety and environmental respect as an excuse to keep competitors away of the European Market.

In this sense, the agrarian associationism is without any doubt a necessary process to be able to respond to these new challenges making viable an agriculture model based on the Family Farms and as the European example shows, where the agrarian cooperatives have been the basic instrument for the development of the most efficient agricultures. At the same time, they present a clear syntony with the Common Agricultural Policy, before the new model of multifunctional agriculture, not only committed with taking place better, with quality and alimentary security, with the environment, with the territory, and with the rural development.

Keywords:

Resumen

En los últimos años, el cumplimiento de los acuerdos comerciales, como la Ronda Uruguay, y la aceptación de la competitividad y la multifuncionalidad como elementos para el desarrollo de la agricultura, vienen implicando el desmantelamiento de los sistemas de protección agrícolas que alteraban la libre competencia en los mercados internacionales.

Por otro lado, la población europea está tomando mayor interés sobre los sistemas de producción orgánica e integrada, como forma de asegurar prácticas agrícolas más respetuosas con el entorno. Las garantías de cumplimiento de estas prácticas pueden

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ser usadas como mecanismos de protección para mantener alejados del mercado europeo a los posibles competidores.

En este sentido, el asociacionismo agrario es sin ninguna duda un proceso necesario para hacer posible que frente a estos cambios que se están produciendo, el modelo de agricultura basado en las explotaciones familiares sean viables, como así pone de manifiesto el ejemplo europeo, donde las cooperativas agrarias han sido el instrumento básico de desarrollo de las agriculturas más eficientes. Al mismo tiempo, estas empresas muestran una clara sintonía con la Política Agrícola Común, pues no sólo se trata de producir más y mejor, sino también de combinar la seguridad alimentaria con la calidad, el respeto al medio ambiente, el territorio y el desarrollo rural.

1 Escenario de la Agricultura Europea en el siglo XXI

Los retos a los que la agricultura y el cooperativismo se enfrentan en el siglo XXI, no pueden sino abordarse desde la consideración y el diagnóstico del nuevo escenario económico y marco institucional en que se encuentran.

Este escenario podemos representarlo mediante las siguientes notas:

- Nos encontramos con una agricultura que produce excedentes ya de carácter estructural. La reforma de la Política Agraria Comunitaria (PAC) en el año 1992 como consecuencia del informe Mc Sharry, puso de manifiesto la necesidad de virar todavía más hacia una política que en lugar de primar a los agricultores vía precios, lo hiciera vía compensaciones directas, además del mantenimiento de las políticas dirigidas directamente a la reducción de producción excedentaria (abandono de tierras, sacrificio de la cabaña ganadera).

Por otro lado, el incremento de la oferta internacional con precios sensiblemente inferiores han sido determinantes claros de una disminución de los precios de los productos agrícolas en términos reales (tabla 1), lo que a la postre ha significado una disminución de la Renta Agraria, si bien en el año 2000 creció ligeramente (1,9%), debido en gran medida a un importante descenso del empleo de mano de obra.

- Los acuerdos internacionales, desde la llamada Ronda Uruguay a la Ronda de Singapur de la Organización Mundial del Comercio y la última Conferencia de la OMC en Doha (Qatar), han supuesto y supondrán acuerdos claramente favorables a una creciente liberalización de los mercados internacionales, que conlleve la disminución de los diferentes mecanismos de protección en las distintas áreas de mercado, pero que a la vez cuestionará también la política de subvenciones a la producción que los

Tabla 1: Evolución de los precios a la producción de productos agrícolas en la UE (deflactados).

Año	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Índice	100	97.2	89.3	84.9	85.0	85.4	83.2	80.1	76,6	73,1

Fuente: Comisión Europea, 1999

diferentes países establecen para sus agricultores y que a la postre alteran la igualdad de concurrencia en los mercados.

En este sentido, conviene apuntar por un lado que la Unión Europea, en la segunda gran reforma de su Política Agraria (PAC), a partir del año 1.992, ya inició un proceso de desmantelamiento o reducción tanto de sus sistemas de protección como de subvención vía precios a sus agricultores. Y por otro lado, en la tercera reforma de la PAC aprobada en el Consejo Europeo de Berlín de marzo de 1.999, se observa que se continuará claramente en esta dirección, con el desarrollo de sus Organizaciones Comunes de Mercado.

Pero no pensemos ni por un momento que sólo la Unión Europea protege su producción agrícola de otros competidores, ya que es bien sabido que existen diferentes mecanismos de protección (aranceles, prelevements, subvenciones a la exportación vía restituciones o vía ayuda alimentaria a través de créditos blandos, controles fitosanitarios) que todos los países utilizan y que lo que diferencia a unos de otros es la opción elegida. Por ello, son muchos los que reivindican que todas ellas sean sometidas a debate en la Ronda del Milenio.

En cuanto a la ayuda a sus agriculturas, todos los países desarrollados tienen subvencionados a sus agricultores, y hoy la Unión Europea no tiene un subsidio mucho mayor que el que disfrutaban otras agriculturas de los países de la OCDE (TAMAMES, 1999). Más aún, con la aprobación por parte de los Estados Unidos de la conocida como Ley Agraria, son muchos los que sitúan las ayudas que percibirán los agricultores americanos muy por encima de las que vienen percibiendo los agricultores europeos.

Por otro lado, debe diferenciarse lo que constituyen ayudas directas a la producción, de las que se destinan a retribuir otras funciones que se reconocen hoy a la actividad agraria desde el enfoque multifuncional, esto es su relación con la política medioambiental, territorios y de desarrollo rural que no debe tener el mismo tratamiento.

- El modelo productivo de la agricultura europea es heterogéneo, coexistiendo países con una notable eficacia productiva en términos de Valor Añadido Neto a precios de mercado por explotación (Van / explotación), como de VAN por Unidades de Trabajo Anuales (VAN / UTAs), como es el caso de Holanda, Dinamarca, Reino Unido y Bélgica, frente a países con tasas sensiblemente inferiores a la media comunitaria, como ocurre en los países mediterráneos (tabla 2), que hacen que una política agraria totalmente uniforme desde un punto de vista territorial no sea todo lo eficiente que debiera, y que de nuevo haga reivindicar un mayor peso de la política de estructuras dentro de la PAC.
- Por otro lado, la PAC ha marcado en cuanto al nivel de apoyo a los distintos sectores, una manifiesta prevalencia hacia los productos continentales frente a los productos típicos de la agricultura mediterránea, lo que sitúa en un escenario aún más desfavorable a la agricultura propia de los países mediterráneos, ya que la mayor parte del presupuesto agrario se destina a tres subsectores: herbáceos, vacuno y lácteos (GARCÍA ÁLVAREZ-COQUE y COMPÉS, 1998).
- La ampliación en un futuro inmediato de la Unión Europea con la adhesión de los llamados Países de la Europa Central y Oriental (PECOs), supone una mayor com-

Tabla 2: Valor añadido neto por Unidad de Trabajo Anual y por explotación en la Unión Europea.

	<i>VAN/UTA (1998)¹</i>	<i>VAN/N^o de explotaciones (1997)²</i>
Bélgica	25.01	27,7
Dinamarca	29.86	37,7
Alemania	17.91	21,2
Grecia	13.14	9,3
España	16.02	13,9
Francia	25.06	36,1
Irlanda	13.92	18,8
Italia	12.72	9,0
Luxemburgo	22.44	33,7
Holanda	27.04	56,9
Austria	11.83	7,4
Portugal	3.91	5,2
Finlandia	14.53	19,6
Suecia	11.20	10,0
Reino Unido	17.39	28,6

Fuente: JULIÁ y MELIÁ (2001).

VAN: Valor añadido neto al coste de los factores a precios corrientes.

UTA: Volumen de la mano de obra agrícola en Unidades de trabajo anual (UTA)

¹Miles de ecus /UTA

²Miles de ecus /explotación

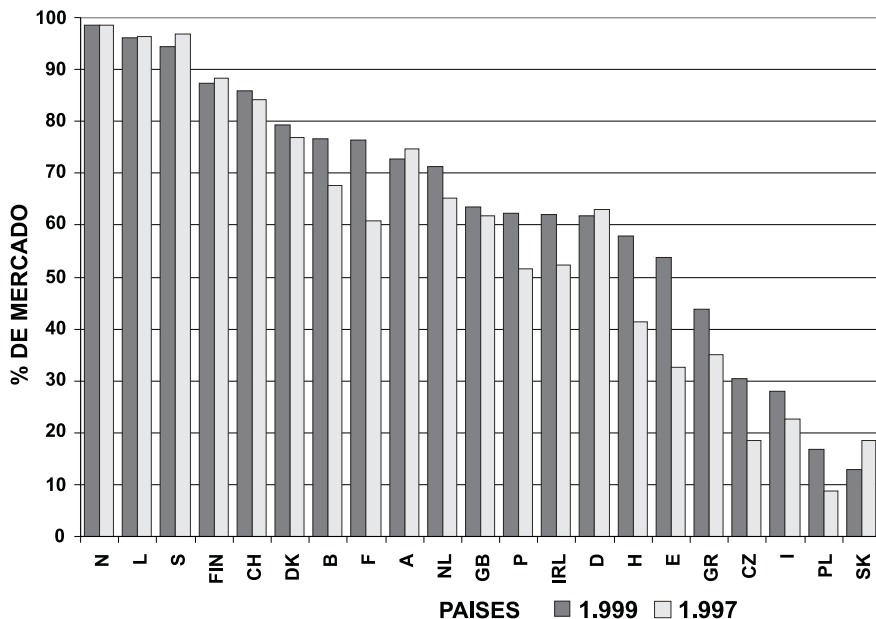
petencia para algunas producciones de los actuales integrantes de la UE ya que la competitividad de los llamados PECO no debe menospreciarse en un contexto nada desfavorable de preadhesión que irá acompañado sin duda de ayudas tal y como se recoge en la Agenda 2000, y que se están materializando ya a través de diversos programas, entre ellos el Programa SAPARD, con una dotación presupuestaria de 500 millones de euros anuales.

- La demanda agroalimentaria ha registrado importantes cambios en la UE, si bien, si nos referimos en términos cuantitativos al consumo de alimentos frescos, el crecimiento experimentado ha sido mínimo, inferior al de la oferta agraria. Sin embargo, otra cuestión bien distinta es el crecimiento del consumo de transformados que ya a finales de los ochenta se cifraba en más del 70% del consumo alimentario (MIONI, 1987). Sin duda, los hábitos de vida y la incorporación de la mujer al mundo del trabajo han sido factores determinantes que han favorecido, al igual que en otras zonas desarrolladas, que este fenómeno se haya producido.

Con todo, el cambio más importante experimentado en cuanto a la demanda agroalimentaria es el fuerte grado de concentración de la distribución alimentaria, ya que en la mayoría de los países de la UE, sólo los cinco primeros grupos de distribución

controlan más del 60% de la demanda (figura I), lo que no es de extrañar si pensamos en la importancia de los grupos de alimentación europeos, que son cuatro de los nueve primeros que figuran en el top mundial.

Figura 1: Participación de los “5 Primeros” en la cifra de negocio de cada país, 1997/1999



Fuente: MIR (2001)

- La creciente preocupación por los temas medioambientales, y de calidad y seguridad alimentaria, unido a una atención preferente a los mismos en la referida Agenda 2000, permite aventurar una serie de oportunidades para el mercado de productos orgánicos o biológicos. De hecho se viene observando un crecimiento si bien todavía no en términos absolutos, sí relativos, de las superficies y producciones de estos productos, registrándose al menos de momento unos precios algo superiores, lo que es un indicador de la preferencia de algunos consumidores por este tipo de productos.

Por otro lado, el posible desarrollo de sistemas de modulación de carácter medioambiental de las ayudas, por aplicación de cláusulas de ecocondicionalidad, es otro factor a tener en cuenta, pues sin duda animará a los productores hacia estas formas de producción cada día más respetuosas con el medio ambiente, producción integrada y producción orgánica.

2 El balance comercial de la agricultura en la Unión Europea

La Unión Europea se configura como un mercado para las producciones agrarias a nivel internacional de un enorme interés, no en balde es uno de los principales importado-

res de algunos productos agrícolas como las frutas y hortalizas, tanto frescas como transformadas del mundo.

Así, si analizamos el comercio exterior agrario de la UE respecto al comercio exterior de todos los productos vemos que las exportaciones de productos agrarios en el año 1.997, supusieron un 7,6% de las exportaciones totales, mientras que el mismo porcentaje para el caso de las importaciones ascendía al 10,6%.

Ya refiriéndonos al sector agrario, las exportaciones de la UE de estos productos vienen representando alrededor de un 14,7% de las exportaciones mundiales de los mismos, si bien este porcentaje varía de forma considerable de unos productos a otros (tabla 3).

Tabla 3: Exportaciones de la UE frente a las exportaciones mundiales para algunos productos agrarios (en porcentaje)

<i>Producto</i>	<i>% exportado</i>
Cereales (excepto arroz)	10,1
Semillas oleaginosas	1,3
Vino	50,1
Azúcar	13,3
Leche	37,6
Mantequilla	26,4
Queso	54,9
Huevos	30,3

Fuente: Comisión Europea, 2001.

Los intercambios de productos agrícolas de la Unión Europea son especialmente intensos con países como Estados Unidos, Rusia o Japón, aunque con signos claramente diferenciados en cuanto a la balanza comercial existente con los mismos. Mientras con Estados Unidos, la balanza comercial es claramente deficitaria para la UE, con países como Rusia, Japón o Suiza, las exportaciones comunitarias superan con creces a las importaciones (tabla 4).

El caso de los intercambios con Brasil merece especial mención dado que mientras la Unión Europea en 1998 exporta productos por valor de 737 millones de ecus, las importaciones ascienden a 5.613 millones de ecus, hecho que sitúa su saldo comercial en primer lugar en cuanto a balanzas comerciales agrarias deficitarias. Por su parte, Argentina es el segundo país en este ranking con balanzas comerciales agrarias deficitarias de la Unión Europea con 2.624 millones de ecus de déficit.

En términos globales, el balance comercial agrario es deficitario al contrario que en otras áreas o mercados como el de Estados Unidos, que con una balanza comercial global deficitaria, presentan un saldo comercial en el capítulo agrario positivo.

Sin embargo, conviene señalar algunos puntos (JULÍA y MARÍ, 2000):

- El saldo comercial no es en todos los productos agrarios deficitario. De hecho, de las producciones más importantes, son las frutas y hortalizas, café, té, y especias las que presentan un saldo netamente deficitario, mientras que para el resto de producciones,

Tabla 4: Comercio de productos agrícolas y alimenticios de la UE con algunos de los principales países clientes, 1.998 (millones de ecus)

<i>País</i>	<i>Exportaciones</i>	<i>Importaciones</i>	<i>Saldo</i>
Estados Unidos	8.034	8.257	-223
Rusia	4.038	420	3.618
Japón	3.627	117	3.510
Suiza	3.131	1.254	1.877
Polonia	1.767	1.046	721
Hong Kong	1.321	59	1.262
Arabia Saudí	1.210	10	1.200
Canadá	1.172	1.162	10

Fuente: Comisión Europea, 2001.

las importaciones son menores que las exportaciones. No obstante, debemos señalar que en el caso de las frutas y hortalizas, el saldo de su balanza comercial en unidades físicas es contrario en función de que se trate de uno u otro producto. Así, mientras que en el caso de las hortalizas, las importaciones ascienden a 855.000 toneladas, y las exportaciones a 1.162.000 toneladas, si se trata de frutas, las importaciones ascienden a 4.401.000 toneladas y las exportaciones a 2.188.000 toneladas.

- Como más adelante comentaremos con detalle, la importación de producciones agrícolas de países terceros cuenta con un contexto más favorable, al reducirse sensiblemente las barreras de entrada. Sin embargo, éstas no han desaparecido en su totalidad, y queda la posibilidad en muchas producciones, en casos de grandes perturbaciones en el mercado europeo, de aplicar cláusulas de salvaguardia especial.
- Otro aspecto importante es el lento crecimiento, y en algunos casos decrecimiento, de las tasas de consumo como consecuencia de un muy reducido crecimiento demográfico y de que las mismas son ya bastante elevadas, como en la mayor parte de los países desarrollados, lo que hace pensar en una satisfacción del consumidor tal, que no cabe suponer que aumente el gasto alimentario de forma significativa en términos globales.
- La Unión Europea constituye uno de los mercados agrarios a nivel mundial más organizados, tanto desde el punto de vista de su regulación a través de la Política Agraria Comunitaria, que para la mayor parte de productos establece las correspondientes Organizaciones Comunes de Mercado, como desde el punto de vista de los operadores, donde si bien existe una clara preponderancia de las grandes multinacionales de la distribución, también han surgido grandes operadores comerciales por el lado de la oferta de los propios productores, con una presencia afortunadamente cada vez más notable, y que utilizando especialmente la fórmula societaria cooperativa, dominan el mercado de ciertos productos agrícolas en algunos estados miembros (tabla 5).

La consecuencia de los fuertes procesos de concentración, especialmente en lo que se refiere a la demanda agroalimentaria ha supuesto una contribución a los procesos de internacionalización y globalización de la distribución, y por ende de las transacciones internacionales de productos agrícolas. Al mismo tiempo se han hecho mucho más

Tabla 5: Producción vendida por medio de cooperativas, 1997 (%)

<i>País</i>	<i>Carne porcino</i>	<i>Carne bovino</i>	<i>Leche</i>	<i>Remolacha azucarera</i>	<i>Cereales</i>	<i>Frutas</i>	<i>Hortalizas</i>
Bélgica	20	0	53	—	30	75	85
Dinamarca	91	66	94	0	60	70-80	70-80
Alemania	27	28	52	80	45-50	40	28
Grecia ²	3	2	20	—	49	57	3
España	8	9	30	23	22	45	20
Francia	85	30	47	16	68	40	25
Irlanda ³	66	15-20	99.5	—	57	14.3	17.5
Italia ¹	13	12	40	6.5	20	43	8
Luxemburgo ³	37	38	81	—	79	—	—
Holanda ³	34	16	83	63	65	76	73
Austria	15	5	90 ²	100 ²	60 ²	18 ²	28 ²
Portugal	—	—	—	—	—	—	—
Finlandia	68	65	97	—	46	—	—
Suecia	78	72.9	100	0	75 ³	20 ³	50 ³
Reino Unido ³	28	—	67	—	24	67	26

¹1994; ²1995; ³1996;

Fuente: Comisión Europea, 2001.

exigentes en las condiciones de entrega de producto, y han encontrado también una correspondencia con la concentración en grandes organizaciones de productores, que configuran un mercado europeo muy vertebrado en el que los pequeños operadores tanto del lado de la demanda como de la oferta tienen poco que hacer.

De hecho, parte de la mercancía que entra de países terceros a la Unión Europea, en algunos casos viene de la mano de operadores europeos¹, que en ocasiones representan a los propios productores, lo que contribuye a una cierta ordenación de la competencia acomodando los calendarios de entrada y buscando incluso sinergias que contribuyan al aumento del consumo total de estos productos que en definitiva beneficien al conjunto de esta producción.

3 El mercado de productos hortofrutícolas en la Unión Europea

Como ya hemos indicado, la Unión Europea constituye uno de los destinos de mayor interés para el comercio internacional de frutas y hortalizas frescas. Así, en 1.997 el volumen de las exportaciones sólo representó el 71% de las importaciones globales, pero únicamente el 53% de las importaciones de frutas (69% en el caso de los cítricos y 43% en el de las demás frutas (COMISIÓN EUROPEA, 1999).

Además, presenta unas interesantes expectativas al ser uno de los mercados de mayor poder adquisitivo y con un crecimiento del consumo, si bien moderado, mayor que el de otros productos alimenticios que conforman la cesta de la compra.

¹ Holandesa Velleman and Tas, italiana Bocchi, alemana Atlanta Scipio, francesa Pomona, británicas Geest, Fyffes y Albert Fisher.

La reforma de la Organización Común de Mercados (OCM) de Frutas y Hortalizas² que dentro de la Política Agraria Comunitaria regula el comercio de estos productos, ha supuesto algunos cambios de especial interés que a continuación pasamos a detallar:

- La promoción y fortalecimiento de las llamadas Organizaciones de Productores con el fin de que éstas planifiquen y programen la producción hortofrutícola adaptándola a la demanda, y se conviertan en elemento básico de regulación del mercado para las producciones propias de la UE mediante las llamadas retiradas de producto.
- Por otro lado, la financiación que la Unión Europea está destinando como apoyo al sector hortofrutícola va a centrarse fundamentalmente en los llamados Programas Operativos, que pueden proponer las Organizaciones de Productores, con el fin de mejorar la producción, reduciendo costes, fomentando prácticas más respetuosas con el medio ambiente, y facilitando las mejoras y el fomento de la comercialización.
- En relación con el régimen de los intercambios comerciales, independientemente de los acuerdos preferenciales que se dan con diversos países, sus aspectos fundamentales son regulados en la propia OCM de Frutas y Hortalizas, y puede afirmarse que, en general, el acceso al mercado comunitario como consecuencia de los acuerdos alcanzados en la Ronda Uruguay del GATT ha mejorado sensiblemente (SERVER IZQUIERDO, 1999).

La reducción de aranceles y equivalentes arancelarios ha implicado una reducción generalizada de los mismos entre 1.995 y 2.000. Para el caso de las frutas y hortalizas la reducción que se acordó fue del 20% y no del 36% como para el resto de sectores. Esta reducción se ha realizado anual y linealmente entre el 1 de julio de 1.995 y el 1 de julio de 2.000.

En cuanto al acceso actual y mínimo, ha implicado el compromiso de la Unión Europea de garantizar el acceso al menos en las condiciones existentes en el momento de la firma del acuerdo y llegar a un nivel de importaciones en el año 2.000 de al menos el 5% del consumo interno. La normalización implica garantizar que las normas sanitarias y fitosanitarias no den origen a nuevas barreras, si bien se reconocía la posibilidad de tomar medidas para la protección de la salud y del medio ambiente. En relación con los acuerdos preferenciales con terceros países, se trata de facilitar la penetración de los productos de algunos países en el mercado comunitario a través de ciertas concesiones arancelarias. Las ofertas de los países destinatarios suponen un acuerdo multilateral, fundamentalmente para que las medidas fitosanitarias no supongan nuevos obstáculos al comercio, lo que no deja de ser paradójico si pensamos en los problemas surgidos con la clementina en el mercado de USA con motivo de supuestos problemas fitosanitarios (mosca del mediterráneo). Otro de los aspectos importantes que salieron del acuerdo de la Ronda Uruguay fue la reducción del apoyo interno, medido a través de la Medida Global de Ayuda, que debería ser del 20% para el conjunto de la agricultura. Por último, también se reguló la reducción de las llamadas restituciones a la exportación, destinadas a cubrir la diferencia entre los precios comunitarios y los internacionales. Las exportaciones subvencionadas a países terceros debían reducirse un 21% en volumen y un 36% en desembolso presupuestario entre 1.995 y 2.000.

² Básicamente se establece en el Reglamento CE 2200/96

4 La agricultura orgánica. Una referencia obligada en el futuro del sector de Frutas y Hortalizas

La producción ecológica, al igual que la producción integrada, están despertando el interés de los productores agrarios en la Unión Europea, ya que se observa por parte de los consumidores un claro aprecio por una alimentación más sana, que además es fruto de unas prácticas de cultivo más respetuosas con el medio ambiente.

Por otro lado, estas formas de agricultura tienen una mayor coincidencia con los nuevos objetivos de la PAC, que como ya hemos señalado, van a favorecer los temas medioambientales.

Estamos por tanto, ante un mercado que puede representar oportunidades de futuro para la agricultura, tanto desde el punto de vista de un previsible mayor apoyo institucional frente a la agricultura convencional, como también desde un punto de vista meramente comercial, ya que todo parece apuntar a un crecimiento de la demanda de este tipo de productos.

Algunos informes señalan como una estrategia de marketing para potenciar la imagen de calidad, la utilización de la producción ecológica o integrada, buscando además el llamado efecto locomotora sobre las ventas de productos convencionales (BRUGAROLAS *et al.*, 1999).

Esta situación parece que es propia de los países desarrollados como se desprende de los resultados obtenidos por Hartman & New Hope, 1.997 para el mercado USA en 1.996, que hablan de cuatro segmentos de compradores (tabla 6).

Tabla 6: Segmentación del mercado norteamericano

Segmento	Compradores ecológicos	Atraídos	Bordeadores o fronterizos	No interesados
% población	10	22	28	40

Fuente: BRUGAROLAS *et al.* (1999)

En el mismo informe se establece un umbral de precios superior para la producción ecológica; de hecho se señala que el 55% de los consumidores habituales estarían dispuestos a pagar un 20% más por estos productos.

Con todo, el mercado de los productos ecológicos todavía presenta una enorme incertidumbre pues las cifras de consumo son reducidas y poco representativas, pudiendo únicamente hablar de indicios de un potencial de mercado que frente a una oferta todavía escasa, ha supuesto precios ciertamente elevados, situación que creemos cambiará con el tiempo, ya que cabe esperar una mayor convergencia en los precios, con un diferencial que en todo caso no será mayor de un 5-10%.

En la Unión Europea, si hablamos de agricultura ecológica, alrededor de un 1,8% de la superficie agraria total se dedica a la misma, siendo Alemania, Italia, Austria y Suecia los que representan la mayor parte de esta superficie de cultivo, que en 1.999 se situó en algo más de 3,3 millones de hectáreas.

Es de destacar, que atendiendo a esta situación, algunos países del norte de Europa, como Suecia o Dinamarca, se están planteando incrementar la superficie de cultivo ecológico para situarla en el presente año 2.000 entre el 10 y el 20% de la superficie total (BRUGAROLAS *et al.*, 1999).

En el caso español, las superficies de cultivo son todavía reducidas, aunque no obstante, se observa un crecimiento. Es el caso de la producción cítrica, donde según los expertos consultados, es previsible que de un 2-3% de superficie de cultivo en la campaña 1.998-1.999, se pasa a un 5% en la 2.000-2.001.

Un reciente estudio (JULIÁ y SERVER, 2000) analiza la viabilidad del cultivo orgánico frente al convencional de cítricos. Los resultados (tabla 7) indican que sólo en un contexto de preferencia alta y muy alta, esto es con diferencias superiores en precio del 30% y 40%, presenta el cultivo orgánico una mayor rentabilidad, mientras que con la hipótesis de tan sólo preferencia, que se corresponde con la situación actual, las tasas de rentabilidad son, como señalamos, favorables al cultivo convencional, si bien las diferencias son reducidas.

Tabla 7: Tasas de rentabilidad del cultivo de naranja según hipótesis de preferencia

	TIR orgánico	TIR convencional
Hipótesis 1: Muy alta preferencia	15,29	12,40
Hipótesis 2: Alta preferencia	12,87	12,40
Hipótesis 3: Preferencia	10,14	12,40
Hipótesis 4: Baja preferencia	6,70	12,40
Hipótesis 5: Sin preferencia	Negativo	12,40

Fuente: JULIÁ y SERVER (2000).

No obstante, debe señalarse que el mercado de productos orgánicos presenta la paradoja de que si bien los precios de los productos comercializados como orgánicos son sensiblemente superiores al de los productos convencionales, en ocasiones se comercializa como productos de agricultura convencional un porcentaje significativo, que en el caso de las frutas en general, cifran en torno al 10%, que en la medida en que la producción orgánica crezca, podría incrementarse de no encontrar los canales comerciales adecuados.

Por último hay que señalar dos cuestiones que son las que mayor preocupación despiertan sobre este tipo de productos, lo que podríamos denominar sus sombras. Por un lado las notables deficiencias en la distribución de estos productos, ya que todavía los grandes operadores no han fijado su atención en los mismos dado su escaso volumen y el nulo grado de asociación del sector (SEIFER, 1997), y por otro, las garantías sobre dichos productos, lo que se denomina la certificación de los mismos, que puede enmascarar mecanismos protectores basados en protecciones a la salud que pueden tener base científica rigurosa, o que pueden ser simples añagazas para alejar a los competidores extranjeros. (VELARDE J., 2000).

5 Las explotaciones familiares y el cooperativismo por una agricultura multifuncional. Unas reflexiones para el sector de frutas y hortalizas en la UE

Los riesgos de una agricultura societaria, expansiva, de grandes producciones, con un alto nivel tecnológico (mecanización), aplicación intensiva de inputs, incorporación de avances de la biotecnología, como los organismos genéticamente modificados (OGM), son mayores en el marco de una política agraria de corte productivista, donde la capacidad de producir marca casi exclusivamente el nivel de ayudas a recibir. Frente a ellas, las empresas familiares agrarias (EFAs), que responden mejor a un modelo social de agricultura que evita el desarraigo de la producción agraria del territorio, más identificado con los enfoques de una agricultura multifuncional, comprometida no sólo con la producción de productos sanos, sino también con el respeto al medioambiente y el desarrollo rural, pueden sentirse amenazadas, dado que ni el mercado ni las ayudas de las políticas agrarias actuales, retribuyen y valoran adecuadamente las funciones no productivas que esta forma de agricultura puede desarrollar.

Pero estas empresas, que sin duda cuentan con la legitimación social de cumplir con los objetivos de una agricultura multifuncional que en la Agenda 2.000 se declara como vocación del nuevo modelo de agricultura para Europa, no pueden declararse ausentes del contexto de globalización y apertura de mercados en el que se encuentran. De ahí que no pueda dejar de ser eficiente la actividad productiva, renunciar a la I+D, y participar en la comercialización y desarrollo agroindustrial de sus producciones.

El asociacionismo agrario es sin duda un proceso necesario para poder atender dichos requerimientos haciendo viable un modelo de agricultura basado en las EFAs, tal y como el ejemplo europeo pone de manifiesto, donde las cooperativas agrarias han sido el instrumento básico para el desarrollo de las agriculturas más eficientes.

El cooperativismo agrario español ha experimentado en las dos últimas décadas un importante crecimiento en términos económicos, asistiendo a un fuerte proceso de concentración empresarial acentuado en los últimos años, constituyendo grandes grupos empresariales cooperativos con sociedades que son líderes en la oferta de algunos productos alimentarios. Por eso, el enorme peso social y económico con que cuentan hoy las cooperativas agrarias en España, que se aproxima ya al de los países de la UE con un a agricultura más desarrollada, les hace imprescindibles para el desarrollo de cualquier política en el sector agrario.

Las cooperativas agrarias tradicionalmente han mostrado una clara sintonía con la Política Agraria Comunitaria de la UE desde sus inicios, que aumenta en el marco del nuevo escenario del siglo XXI, máxime si atendemos al deseo de configurar una nueva política europea agrícola y rural, que pretenda el modelo de una agricultura multifuncional, no sólo comprometida con producir mejor, con calidad y seguridad alimentaria, con el medio ambiente, con el territorio, y con el desarrollo rural.

La formación de su base social es un objetivo para las cooperativas obligado, no sólo por su propia naturaleza cooperativa (principio cooperativo de formación) sino porque resulta necesario para desarrollar una verdadera participación y afrontar con éxito los nuevos

retos que como empresa participativa constituida por agricultores para el desarrollo de una nueva agricultura se van a encontrar.

Ante el escenario descrito cabe plantear como conclusiones algunas acciones que deberían ser abordadas por el cooperativismo agrario español con mayor premura (JULIÁ y SERVER, 1999).

En primer lugar y en relación con la actividad productiva, parece claro que deben ser las propias organizaciones cooperativas las que fomenten entre sus socios un compromiso con una nueva forma de producir más eficiente, que persiga la calidad y el respeto al medioambiente, a la vez que intente atender a las nuevas demandas de los consumidores. En el caso del cooperativismo agrario español, con un problema claro de estructura en su modelo productivo, se debe tratar de transferir tecnología y más aún, animar procesos que supongan reducción de costes, esto es, continuar facilitando el abaratamiento en la adquisición de inputs, pero racionalizando su empleo, con un asistencia técnica adecuada y favoreciendo el uso en común de algunos inputs (equipos de riego, maquinaria, etc.)

Las nuevas formas de agricultura, con canales comerciales todavía no muy desarrollados, y también porque no decirlo, con una práctica productiva escasa, hacen necesario que las organizaciones cooperativas vayan adquiriendo un mayor compromiso, ayudando al agricultor desde un punto de vista técnico, pero además intentando establecer canales de distribución que faciliten la salida de estos productos.

El aumento del consumo de transformados ha puesto de manifiesto la necesidad de un desarrollo industrial en la agricultura. Una muy buena parte de la producción agraria se ofertará, cada día más, como un producto agroalimentario transformado, y de ahí la necesidad de que las cooperativas agrarias estén presentes en el sector agroindustrial, garantizando así la participación de los productores en esta fase de la cadena agroalimentaria, que cada día va adquiriendo un mayor relieve.

La asunción de estos nuevos retos con los que se enfrenta la agricultura y el cooperativismo europeo, requieren inevitablemente unas organizaciones cooperativas eficientes, lo que significa la no renuncia al logro de aquellos elementos que constituyen las variables competitivas en un mercado globalizado y abierto como el actual, destacando entre éstas claramente la dimensión empresarial, que deben alcanzar mediante los diversos procesos de agrupamiento que ya han iniciado.

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Use of Combined Economic Threshold Level to Control Insect Pests on Cotton

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Abstract

The economic threshold level (ETL) is a key factor to be studied for insect pests control. It is difficult to monitor cotton insect pests separately, and it is not reasonable to base decision-making for spraying on an ETL of individual insects and ignore sub-levels of other cotton insect pests. So, we want to use a combined ETL in a way of insect units, to put all major insect pests to consideration as an insect pests' complex. This means delaying the first spray to give a chance for natural enemies to develop and then lower the number of sprays and consequently reduce the cost of production.

Keywords: cotton, insect pest, economic threshold level

1 Introduction

Cotton in the Sudan is grown in the black cracking soil of the central clay plain, where rainfall ranges between 400 - 800 mm per annum (SCHMUTTERER, 1969). However, cotton is the backbone of the Sudan economy. Its contribution is more than 40 % of Sudan export values (MORSAL, 1992). One of the limitations of cotton production in Sudan is the insect pests. Their control contributes a great deal in the cost of production. The major cotton insect pests are the African bollworm, *Helicoverpa armigera* (Hubn); the cotton Jassid, *Jacobiasca lybica* (de Bergevin); the cotton white fly, *Bemisia tabaci* (Genni) and the cotton aphid, *Aphis gossypii* (Glov), (MATTHEWS, 1989).

2 Materials and methods

2.1 The Insect Units

For protection of the cotton crop against insect pest complex damage, the group entomologist in the cotton producing schemes in Sudan used to intervene by chemical control when the insect pest level reached or passed the economic threshold level. However, in most cases they only considered spraying one pest and ignored the sub-levels of infestations of other insect pests. In this study we believe that the sub-levels could be even more serious in reducing cotton yield as in the case of jassid, for instance. To avoid persistence, for longer period of such sub-levels we suggest considering the insect units. The principle of the insect unit technique is as follows:

The major insect pests of cotton are the African bollworm (*H. armigera*), the jassid (*J. Lybica*), the white fly (*B. tabaci*) and the aphid (*Aphis gossypii*). Hypothetically, if the

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count of jassid shows 30 nymphs per 100 leaves, the African bollworm shows 5 eggs plus one larvae per 100 plants, the white fly population 150 adults per 100 leaves and the aphid infestation is 5. None of the above reaches the sprayable level, and if we convert the numbers into units it will be as shown in Table 1

Table 1: Insect units

<i>Insect pests</i>	<i>Conventional recommended ETL</i>	<i>Units</i>
African bollworm	10 larvae and / or eggs	0,8
Jassid	50 nymphs	0,6
White fly	200 adults	0,75
Aphid	20% %	0,25

When we combine the above mentioned infestation levels we believe that the impact on cotton could be damaging; specially if the Situation persists for a long time. Then, if we use the insect units, we could overcome the difficulties of the classical method of decision making in spraying of cotton by considering the sub-levels of the four insect pests infesting the crop.

2.2 Field studies

In this study two locations were selected: one in Gezira Research Farm (GRF) of Gezira Research Station (GRS), where the cotton variety Barakat 90 was planted, and the other location was in Rahad Research Farm (RRF) of the Rahad Research Station (RRS), where the cotton variety grown was Acala 67B. However, it was conducted in season 1997/98. In each location six levels of infestations were used and laid out in a randomised complete block design; (RCB), replicated four times.

The experimental plot size in both sites was (8x8m), the levels of infestation were 2R, 3R, 4R, 5R, current ETL(CRT.ETL) and untreated control (Untr.), where (R) was based on conventional ETL as shown in Table 2.

Table 2: Explanation of the (R) unit

<i>Insect pest</i>	<i>African bollworm</i>	<i>Jassid</i>	<i>Whitefly</i>	<i>Aphid</i>
Conventional ETL	10 larvae and/or eggs per 100 plants	50 nymphs per 100 leaves	200 adults per 100 leaves	20% infested plants
Current ETL	10 larvae or 30 eggs per 100 plants	70 nymphs per 100 leaves	600 adults per 100 leaves	40% infested plants
Hypothetical observation	5 larvae per 100 plants	30 nymphs per 100 leaves	150 adults per 100 leaves	5% infested plants
Insect unit (R)*	0.5	0.6	0.75	0.25

$$*R=0.5+0.6+0.7+0.25=2.1$$

The sowing date for Barakat 90 was 7th August and for Acala 67B was 16th July 1997. Seed rate and spacing were performed as standard procedures used in Gezira and Rahad schemes for cotton production: 80 cm between ridges and 50 cm between plant holes. Five seeds per hole were used and thinned to 3 plants per hole 3 weeks after germination. Nitrogen fertiliser was applied as urea (46%) at the rate of 80 kg / feddan. Each plot was hand-weeded 4 times. Depending on the insect pest infestation, different insecticides were used as shown in Table 3.

Table 3: Insecticides used in combined ETL experiments

Gezira Research Farm (GRF)			
<i>Brand name</i>	<i>Common name</i>	<i>Dose litre/feddan</i>	<i>g.a.i/feddan</i>
Endosulfan 50 EC	Endosulfan	0.75	375
Curacron 400 EC	Profenophos	0.50	200
Talstar 2.5 EC	Biphinthrins	0.6	15
Dursban 48 EC	Chlorpyrifos	0.75	365
Reldan 50 EC	Chlorpyrifos methyl	0.75	375

Rahad Research Farm (RRF)			
<i>Brand name</i>	<i>Common name</i>	<i>Dose litre/feddan</i>	<i>g.a.i/feddan</i>
Larvin 80 DF	Thiodicarb	0.3*	240
Endosulfan 50 EC	Endosulfan	0.75	375
Curacron 400 EC	Profenophos	0.50	200

*kg/feddan

2.3 Insect counts

Regular periodical counts of the African bollworm *H. armigera* (eggs and Larvae) were taken from 100 plants in each subplot, where the top was examined for eggs and fruiting bodies were checked for larvae. Jassid nymphs (*J. lybica*) and white fly adults (*B. tabaci*) were counted on 20 plants at random in each subplot. In each plant 5 fully - grown leaves were inspected: 2 upper, 1 middle, and 2 lower on the main stem. The aphid counts were taken in terms of infested plants based on the absence or presence of the insect irrespective of the pest density on the plants. Scouting normally started early in the morning around 6. a.m.

2.4 Data collection

Insect pest population counts were carried out weekly. However, when the sprayable level was attained, the plots were sprayed one day later with the appropriate insecticides, according to the pest situation. Spraying was carried out using a knapsack sprayer with

a delivering spray volume of 100 litre per feddan. The first post spray count was carried out two days after spraying.

2.5 Statistical analysis

The effect of each level of infestation (R) on cotton quantity and quality was recorded. The yield of cotton, (kantar / feddan) for the different treatments was analysed using ANOVA and Duncan's Multiple Range Test (DMRT) at 5% level of significance to separate between means. The statistical analysis for insect counts was made throughout the season to show the relative general performance of the insect pests.

The evaluation for fibre quality and degree of stickiness was done in co-operation with the Fibre Spinning and Stickiness Laboratory of the Agriculture Research Corporation (ARC). Fibre graphs 530 were used to determine the length parameters (2.5 %S.L mm). For uniformity ratio, (UR) Pat-Ar was used, for maturity and fineness, Micronair Value (MV) was done. The strengths were measured using the sterlometer. Thermodetector (SCT) was used to detect the number of sticky spots. All these procedures were carried out under laboratory conditions at $65\% \pm 2\%$ RH at $20^{\circ}\text{C} +2$.

3 Results

The results of combined economic threshold level (ETL) were presented as cotton yield in kantar per feddan (K/F), quality of cotton and insect counts. These were shown as follows:

3.1 Cotton yield

Cotton yield per feddan due to different levels of infestation is shown on Table 4.

In the Barakat 90 variety at low level of infestations (R_2) the number of sprays was twice that of the high level of infestation (R_5).

In the Acala 67 B variety, the number of sprays at a low level of infestation (R_2) was 1.5 more than that at high level of infestations (R_5). However, in all treatments the number of Sprays were higher in the Barakat 90 variety compared to the Acala 67 B variety. In the Barakat 90 variety the yield in kantar per feddan was not significantly different at 5 between the low level of infestation (R_2) and the high level of infestation (R_5) perhaps due to the considerable experimental error (C.V 19.7%). Yet, the difference in yield was almost equivalent to one kantar /feddan.

The current ETL showed a significant difference at 5% in yield compared to the high level of infestation (R_5). However, the difference was more than one kantar per feddan, but the difference in yield was not significant at 5% from the rest of levels of infestation, R_2 , R_3 and R_4 . However, control of insect pests at all levels of infestation increased the cotton yield significantly at 5% from the untreated control. At most levels of infestations the yield of the untreated control was equivalent to less than 50% (Table 4). In the Acala 67B variety the yield in kantar per feddan was not significantly different at 5% level between all levels of infestation except the untreated control, where the difference in yield was more than 2 kantar per feddan. However, compared to all levels of infestations the yield of the untreated control was equivalent to more than 50% (Table 4).

Table 4: The effects of combined ETL on cotton yield. Means of seed cotton yield for two varieties

<i>Treatments</i>	<i>Barakat 90</i>		<i>Acala 67 B</i>	
	<i>No. of Sprays</i>	<i>Yield (K/F)</i>	<i>No of Sprays</i>	<i>Yield (K/F)</i>
R ₂ (2 units)	8	3.7 ab	3	6.8 a
R ₃ (3 units)	6	4.2 a	3	7.4 a
R ₄ (4 units)	5	3.8 ab	2	7.3 a
R ₅ (5 units)	4	2.8 b	2	6.5 a
Current ETL	7	4.2 a	3	7.4 a
Untreated control	-	1.7 c	-	4.6 b
S.D. ±		0.66		0.823
CV (%)		19.7		12.4

3.2 The cotton quality

Fibre quality characteristics of varieties under test were influenced by the different levels of pests' infestation (Table 5). However, in both cotton varieties used, the different levels of infestation showed no differences at all levels of infestation in the span length (Table 5).

Fibre fineness and maturity had shown no differences between all levels of infestation in both varieties (Table 5). Strength elongation showed a clear difference between the levels of infestation. However, in both varieties R₃ level and the current ETL treatments were better than other levels of infestation (Table 5). Nevertheless, the untreated control was lowest in both varieties Barakat 90 and Acala 67 B (26.7, 18.3 respectively).

The different levels of infestations showed differences in stickiness compared with the untreated control in both varieties. However, R₃ and the current ETL treatments were better than the other levels of infestations in both varieties (Table 5). The grade showed similar results concurrently with the stickiness values (Table 5).

3.3 Statistical analysis (general performance of the insect units)

For Barakat 90, the major insect pests were the jassid and the aphid (Table 6). The African bollworm presence was nil, while the white fly was scarce. For jassid, the general performance of the insect units CRT. ETL treatment was similar to that on R₂ and significantly different compared to other levels of infestations. However, for aphid control similar results were obtained with CRT. ETL, R₂ and R₃. These latter levels of infestations were significantly different compared to the other levels (Table 6). For Acala 67B all the insect pests complex were present with the dominant presence of the African bollworm and jassid (Table 7). However, the level of the African bollworm was nil at the time of the first post spray count of the treatment R₅. Jassid infestation was mediocre. Aphid and white fly control in R₂ and R₃ were significantly better than CRT. ETL. (Table 7).

4 General discussion

The combined economic threshold is one of the factors that greatly influences plant growth and development. The effects appeared to be essentially an expression of the response of the cotton plant to insect pests incidence. These insect pests are capable of having direct and indirect effects on cotton quantity and quality.

4.1 The cotton yield

In all tested treatments of the combined ETL, the number of sprays were greater in the Barakat 90 variety compared to the Acala 67 B variety; this is because Barakat 90 takes a longer time for maturation than Acala 67B (MATTHEWS, 1989). It also may be related to the influence of other agronomic factors. In the Barakat 90 variety, the R_2 level, which was the lowest level, gave a higher cotton yield than the untreated control (3.7, 1.7 K/F respectively,). However, the difference was almost two kantars per feddan (Table 4). A similar result was obtained from Acala 67B for R_2 and the untreated control, (6.8,4.6K/F respectively) (Table 4). The R_3 level and the current ETL treatments gave similar cotton yields which were (4.2 K/F) in Barakat 90 and (7.4 K/F) in Acala 67B (Table 4). They differ slightly however with respect to the number of sprays in the Barakat 90 variety. However, the difference was only one spray. This indicated that the combined ETL compares well with the current ETL. Nevertheless, the R_3 and the current ETL treatments produced higher cotton yields than the untreated control (Table 4). These studies were in accordance with the previous study, done on a large scale, which showed an increase of one kantar per feddan (ABDELRAHMAN *et al.*, 1991). However, the differences with the high levels of infestations, R_4 and R_5 , were more than one kantar per feddan compared with the untreated control. A similar result was obtained when these were compared with the R_3 level. However, there was a decrease in cotton yield with the increase of insect units (R) (Table 4).

Nevertheless the difference in R_3 level was significant compared with untreated control and other levels of infestation in the Barakat 90 variety. In Acala 67B however there were no significant differences between cotton yield from the different levels (R) of infestations except for the untreated control (Table 4). The results indicated that the R_3 treatment is the best one with regard to cotton yield. However, to all levels of infestations the yield of untreated control was less than 50% (Table 4).

4.2 The cotton quality

Fibre quality was influenced by the different levels of infestation. However, the cotton fibre span length did not show any differences between levels of infestation in both varieties (Table 5); this may be attributed to inheritance characters. A similar result was obtained for the micronaire value because the levels of infestation showed no differences in the micronaire value in both varieties (Table 5). But the R_3 and the current ETL treatments showed significant differences in the strength elongation in both varieties compared with the untreated control (Table 5). These indicate that R_3 and current ETL were better than other levels of infestation (R_2 , R_4 , R_5 and untreated control). The different levels of infestation had shown differences in stickiness as evident by the number of sugar spots. However, the untreated control had the highest number of spots

for both cotton varieties (Table 5). The R_3 level and the current ETL had the lowest stickiness spots. However, the two levels were found to have a higher number of spots in Acala 67B compared to Barakat 90 variety. This may be due to a non sprayable level recorded for the white fly throughout the season, in the Barakat 90 variety, while they reached sprayable level of aphid earlier in Acala 67B.

These results of stickiness were supported by the grade reported in Table (6). In spite of the higher number of sprayings in R_2 level, in both varieties (8, and 3 sprays), the stickiness was greater compared with the other levels of infestation (Table 5). This indicates that the number of sprays was not a factor in protecting cotton from stickiness.

4.3 Statistical analysis

The insect counts were analysed as general performance throughout the season. The statistical analysis shows significant differences between the levels of infestation (R) in both varieties (Tables 6 and 7).

In Barakat 90, the African bollworm gave a similar result in the statistical analysis, because the African bollworm was not a problem and/or not reached sprayable level at any levels of spraying (Table 6). In Acala 67B the African bollworm was a problem when the first and second sprays were directed towards its control. Also, significant differences between the levels of infestations were found (Table 7). Nevertheless, the R_2 and R_3 levels were statistically better than other levels of infestation and they did not differ in cotton yield (Table 4). This indicated that the African bollworm needs a good management according to the stages of the crop growth (BALLA, 1978; ABDELRAHMAN *et al.*, 1991).

In Barakat 90 the cotton jassid was dominant throughout the season. However, the statistical analysis showed significant differences between the levels of infestation in the different treatments (Table 6). Nevertheless R_2 was the best one (Table 6), while in Acala 67B R_2 and R_3 were the best ones (Table 7). These results indicate that the ETL of infestation differs according to the type of variety. But when we related the statistical analysis with the production and the number of sprays, we found that R_3 is the best level compared with other levels of infestation (Tables 4, 6 and 7).

In Barakat 90 the white fly was not the dominant insect pest. However, the statistical analysis showed significant differences between the levels of infestation in the different treatments (Table 6). The R_3 and the current ETL treatments mostly had similar results and were not statistically different in cotton yield (Tables 4 and 6), though they differ in the number of sprays (Table 4). These indicate that R_3 level was similar to the current ETL. While in Acala 67 B the R_3 level was statistically better than current ETL (Table 7).

In Barakat 90 the aphid was the dominant pest throughout the season. However, the statistical analysis showed significant differences between the levels of infestation (R). Nevertheless, no significant differences were found between R_2 , R_3 and the current ETL treatment (Table 6). They differ however in cotton yield and the number of sprays (Table 4). These indicate that R_3 level was the best ones (6 sprays) and 4.2 K/F cotton yield (Table 4). But in Acala 67 B the R_2 and R_3 levels mostly showed similar statistical results in general performance throughout the season and they differ from the current

Table 5: The effects of spraying on the number of insect pests complex of two cultivars on cotton quality during 1997/98

Cultivars	Treatment	2.5% Span length	Micronaire value (mv) (fineness+maturity)	Strength elongation (m) (steliometer 1/8 g/tax)	Stickiness	Grade	No. of sprays
Acala 67B	R ₂	26.7	3.8	18.9	28	2	3
	R ₃	27.0	3.7	20.5	16	2	3
	R ₄	26.8	3.9	19.3	27	3	2
	R ₅	26.8	3.7	20.0	31	3	2
	CRT. ETL	27.1	3.8	20.3	14	2	3
	Control	26.4	3.9	18.3	39	3	-
Barakat 90	R ₂	31.7	3.6	27.1	11	4	8
	R ₃	32.3	3.5	27.4	5	3	6
	R ₄	31.7	3.4	27.2	13	4	5
	R ₅	31.9	3.7	27.1	15	4	4
	CRT. ETL	32.2	3.7	27.7	5	2	7
	Control	31.9	3.9	26.7	16	4	-
Key	25.5-29.9	3.5 fine	18-19 low	0-2 not detachable			
		4.5 average	20-21 average	2-16 light			
		5.5 coarse	22-23 high	17-23 medium			
				23-50 strong			

Table 6: The general performance of the insecticides used on the different treatments during the period 21/9 - 27/12/1997 Variety Barakat 90, Gezira Research Farm - Season 1997 - 1998 (actual figures in brackets)

<i>Treatments</i>	<i>Jassid nymphs per 100 leaves</i> ¹	<i>White fly per 100 leaves</i> ²	<i>%age of Aphid infested plants</i> ³
R ₂	7.7 a (60)	7.1 ab (50.3)	18.7 a(10.3)
R ₃	8.2 b (67.5)	7.3 ab (53.0)	20.5 a (12.3)
R ₄	9.7 c (87.8)	7.6 b (57.8)	22.9 b (15.3)
R ₅	10.9 d (119.3)	7.4 ab (54.3)	23.9 b (16.5)
CRT. ETL	7.7 a (59.6)	6.9 a (48.8)	20.5 a (12.3)
Untr. Control	15.4 e (236.0)	8.7 c (76.5)	37.8 c (37.5)
S.E. (±)	0.64	0.17	0.34
C.V. (%)	9.6%	4.6%	4.6%

¹ Data transformed to \sqrt{x} , (mean of 19 counts)

² Data transformed to \sqrt{x} , (mean of 17 counts)

³ Data transformed to $\arcsin x$, (mean of 19 counts)

Means followed by the same letter were not significantly different at 5% level using Duncan's Multiple Range Test

Table 7: The general performance of the insecticides used on the different treatments during the period 21/9 - 27/12/1997 Variety Acala 67 B, Rahad Research Farm - Season 1997 - 1998 (actual figures in brackets)

<i>Treatments</i>	<i>A.B.W.(eggs + larvae) per 100 plants</i> ¹	<i>Jassid nymphs per 100 leaves</i> ²	<i>White fly per 100 leaves</i> ³	<i>% age Aphid infested plants</i> ⁴
R ₂	1.4 a (1.0)	4.9 ab (24.8)	10.1 a (102.8)	19.6 a (11.3)
R ₃	1.4 a (1.0)	4.7 a (22.5)	10.3 a (107.0)	22.2 b (14.3)
R ₄	1.7 b (2.0)	5.1 ab (26.3)	11.0 b (121.3)	23.6 bc (16.0)
R ₅	–	7.1 c (50.8)	16.1 d (258.3)	27.9 c (22.0)
CRT.ETL	1.9 b (2.5)	5.5 b (30.0)	12.8 c (162.8)	28.8 d (23.3)
Untr. Control	4.4 c (18.8)	8.8 d (76.8)	18.2 e (332.3)	54.0 e (65.0)
S.E (±)	0.14	0.20	0.36	4.09
C.V. (%)	7.1%	6.8%	2.8%	13.9%

¹ Data transformed to $\sqrt{x+1}$, (mean of 7 counts)

² Data transformed to \sqrt{x} , (mean of 7 counts)

³ Data transformed to \sqrt{x} , (mean of 7 counts)

⁴ Data transformed to $\arcsin x$, (mean of 7 counts)

Means followed by the same letter were not significantly different at 5% level using Duncan's Multiple Range Test

ETL (Table 7). These agree with ABDELRAHMAN *et al.* (1991) results in which ETL of aphid was increased from 20% aphid infestation to 40%.

5 Summary and conclusions

The findings of the present study can be summarised as follows:

- 1) The economic threshold is dynamic (action threshold) according to the variables such as cotton yield, number of sprays and their impact on the natural enemies as well as the cotton variety and growth stages.
- 2) The dominant insect pests in the cotton crop were the cotton jassid, the cotton aphid and to a lesser degree the cotton white fly as well as the African bollworm.
- 3) The number of sprays was not a factor in improving the cotton quality as well as reducing the stickiness.
- 4) The use of R_3 level was the most effective method compared to the classical method. However, this level does not differ significantly from the current ETL and hence needs more investigations on small and large scale levels.
- 5) The R_3 level (3 units), was the best level to be used as a combined threshold for the cotton insect pests complex.

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Time-Course Changes in High Temperature Stress and Water Deficit During the First Three Days After Sowing in Hydro-Primed Seed: Germinative Behaviour in Sorghum

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Abstract

Both drought and heat stresses substantially influence the germination pattern and subsequent establishment rates of sorghum. The timing of high temperature occurrence, along with water deficit after seed sowing is investigated and methods for its alleviation are evaluated. Two experiments were conducted on CSV 15 sorghum seeds after soaking treatments in 2, 4 or 6g $NaCl\ l^{-1}$ solutions. Several high temperature stress scenarios of 45°C were administered at various times during the second day after sowing, or at a fixed time during the first, second or third days after sowing. Results revealed that the 18th hour of the second day after sowing is more sensitive, in terms of the final germination percentage and germination index attained, than the 6th, 12th or 24th hour. Seed treatment with 2g $NaCl\ l^{-1}$ was superior to untreated seeds in its response to high temperature stress, attaining more positive germinative characteristics. Heat shock on the first day after sowing had more negative impacts on germination than on the second or third days. It also caused an increase in radicle growth at the expense of plumule growth, thus decreasing the plumule:radicle ratio.

Keywords: Heat, water-deficit, germination, seed treatments

1 Introduction

Rapid emergence is a trait under genetic control for all crops including sorghum, but its manifestation depends on the prevailing environmental factors (MADAKADE, I. *et al.*, 2001). Temperature extremes are known to have major detrimental effects on biological systems (LIN, J. and SUNG, J., 2001) and this is most clearly observed in germination (AL-MUDARIS and JUTZI, 1998b,c,a). A seed sown to germinate may be exposed to varying environmental conditions in the seedbed before it emerges above the soil surface. These may include high temperatures within the supra-optimal range, limited moisture or both. The timing of environmental stresses, and not just their intensity, may play a major role in outlining the crop's subsequent emergence pattern (FERRARI, L. and LOPEZ, C., 2000; CASTELLANI and AGUIAR, 2001).

The effects of stress intensity have received considerable attention (GALLARDO, K. *et al.*, 2001; TESNIER, K. *et al.*, 2002), whereas studies on the effect of timing of stress

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events after sowing are scarce (GALLOWAY, L., 2001; JOHNSTON, M. *et al.*, 2002). In this paper, the basic argument that timing of heat shock affects the germinative response of seeds was investigated. We also tested the hypothesis that hydro-priming alters the time-dependent response of seeds to both water deficit and high temperature stress. The first three days after sowing were chosen as the scenario-implementing period based on previous work in this laboratory (KADER, M., 2001; KADER, M. and JUTZI, S., 2001, 2002) and other studies (DEMIR, I. and VAN DE VENTER, H., 1999; CHACALIS and SMITH, 2001).

2 Materials and Methods

2.1 Effect of Heat Shock During the Second Day After Sowing

Three osmotic hydro-priming seed treatments were applied to sorghum (*Sorghum bicolor* L. Moench) CSV 15 seeds. Certified seed lots were obtained from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and analysed following International Seed Testing Association regulations (ISTA, 1993). Lots used in this study had germination percentages of 99.2%, moisture content of 13.8% and viability of 98.9% (tetrazolium). Seeds were soaked in solutions of 2, 4 or 6g NaCl l^{-1} for 2 days (d) at 25°C in the dark. Dry, untreated seeds served as the control.

After treatment, seeds were surface dried (Voetsch Apparatus, Germany) at 25°C for 5 hours (h) and sown in batches of 100 seeds in 1 L polystyrene trays over creased filter paper (Schuess, Germany). Each tray received 40 ml of a polyethylene glycol 10,000 (Fluka Chemie, Germany) solution with an osmotic potential (Ψ_s) of -10 bar to simulate drought. Trays were then arranged in germination cabinets (Convicon Industries, Canada) and exposed to one of five scenarios representing variation in timing of heat shock as follows:

Scenario 1: No heat shock (Control: Seeds exposed to a continuous 30°C temperature during the whole 10 d test period, hereafter termed No Shock)

Scenario 2: Seeds exposed to a 45°C heat shock on the first 6 hours of the second day after sowing, and to a constant 30°C temperature thereafter (termed 6th hour)

Scenario 3: Seeds exposed to a 45°C heat shock from the 6th to the 12th hour of the second day after sowing, and to a constant 30°C temperature thereafter (termed 12th hour)

Scenario 4: Seeds exposed to a 45°C heat shock from the 12th to the 18th hour of the second day after sowing, and to a constant 30°C temperature thereafter (termed 18th hour)

Scenario 5: Seeds exposed to a 45°C heat shock from the 18th to the 24th hour of the second day after sowing, and to a constant 30°C temperature thereafter (termed 24th hour)

Seeds were scored daily for their germination for the whole 10 d period and from this data, the final germination percentage (FGP), mean germination time (MGT) and germination index (GI) calculated (BENECH ARNOLD *et al.*, 1991). On the 10th day after sowing, 10 germinated seeds were randomly removed from each tray and their plumules

and radicles excised, dried at 80°C for 3 d, weighed and averaged. This gave the dry weight of plumule (DWP), dry weight of radicle (DWR) and, by dividing the DWP by the DWR, the plumule: radicle ratio (PRR). Data from the six replications of each treatment (scenario combination) were subjected to an analysis of variance procedure (ANOVA) (WEBER, E. and ANTONIO, C., 1999) and mean separation, after arsine transformation of germination percentages (HOULE, G. *et al.*, 2001), was executed by Duncan's Multiple Range Test ($\alpha = 0.05$) (SAS, 1989).

2.2 Effect of Heat Shock During the First Twelve Hours of the First, Second or Third Day After Sowing

The same seed treatments (Dry Control, 2, 4 and 6g NaCl l^{-1}) mentioned above were applied to CSV 15 seeds. All conditions were similar to the previous experiment (including the -10 bar drought stress) except that seeds were exposed to one of four heat shock scenarios during the first three days after sowing as follows:

Scenario 1: No heat shock (as described above)

Scenario 2: Seeds exposed to a 45°C heat shock on the first 12 hours of the first day after sowing, and 30°C otherwise (termed Day 1)

Scenario 3: Seeds exposed to a 45°C heat shock on the first 12 hours of the second day after sowing, and 30°C otherwise (termed Day 2)

Scenario 4: Seeds exposed to a 45°C heat shock on the first 12 hours of the third day after sowing, and 30°C thereafter (termed Day 3)

Here, also, 100 seeds/tray were replicated six times, observed daily for 10 d and the FGP, MGT, GI, DWP, DWR and PRR determined and analysed as above.

3 Results and Discussion

3.1 Effect of Heat Shock During the Second Day After Sowing

The results of Table 1, showing the pooled effects of seed treatments, indicate that the 2g NaCl l^{-1} treatment yielded the highest FGP. Although the dry control germinated to a greater extent than the 4 or 6g NaCl treatments, all three salt concentrations (2, 4 and 6g) significantly increased the speed of germination by reducing the MGT. The GI, relating the final germination percentage with germination speed, was greater in 2g NaCl -treated seeds than in all other treatments, which did not significantly differ from each other. All three salt treatments gave greater DWP and DWR values than their untreated counterparts, but the PRR, did not differ between treated and untreated seeds (Table 1).

Timing of the 45°C heat shock did not clearly affect germination in the way treatments did. Whether it was administered on the 6th, 12th or 24th hour of the second day after sowing, heat shock did not modify the FGP, its speed or index (data not shown). The DWP and DWR were also unaffected. However, heat shock on the 18th hour produced a lower FGP than that on the 6th or 12th hour, and a lower GI than all other timings (No Shock, 6th, 12th or 24th hour) (data not shown). The DWP was not clearly affected by heat shock timing, but shock on the 12th hour gave higher DWP values than the

Table 1: Effect of seed treatments on germination and seedling characteristics of sorghum CSV 15 under various heat shock scenarios and drought

Seed Treatment (g NaCl/l)	FGP (%)	MGT (day)	GI	DWP (mg)	DWR (mg)	PRR
0 (Dry Control)	89.0 b	3.4 a	670.0 b	2.9 c	1.3 c	2.2 a
2	94.3 a	2.4 c	805.6 a	4.4 a	2.3 a	1.9 a
4	80.6 c	2.9 b	650.1 b	4.2 ab	1.9 b	2.2 a
6	81.0 c	2.4 c	690.2 b	3.9 b	1.8 b	2.2 a

Means in columns followed by similar letters are not significantly different according to Duncan's Multiple Range Test ($p \leq 0.05$). FGP: Final Germination Percentage, MGT: Mean Germination Time, GI: Germination Index, DWP: Dry Weight of Plumule, DWR: Dry Weight of Radicle and PRR: Plumule: Radicle Ratio.

No Shock scenario. The No Shock and 6th hour shock scenarios gave lower PRR values than the 12th, 18th or 24th hour shock treatments.

Interactive analysis exhibited the same trend, with the 2g NaCl l⁻¹ treatment being superior to other seed treatments and the 18th hour shock event timing exhibiting partial sensitivity (Figs. 1a-c and 2a-c).

3.2 Effect of Heat Shock During the First Twelve Hours of the First, Second or Third Day After Sowing

All three salt treatments increased the speed of germination, with the 2g NaCl treatment yielding the highest GI, DWP and DWR (data not shown). Seeds treated with 2g NaCl also exhibited a higher FGP than untreated or 6g NaCl-treated seeds, but the PRR was not affected by seed treatments. Analysis of the effects of heat shock scenarios (data not shown) revealed a lower FGP for non-shocked and Day 1-shocked seeds than Day 2 or 3-shocked ones. The MGT was not affected by shock treatment, but Day 1-shocked seeds gave the lowest GI and PRR. DWP did not differ among shock treatments, but the DWR values of non-shocked seeds were lower than those of Day 1 or Day 2-shocked counterparts.

The results of interactive analysis of seed treatment (heat shock revealed that the FGP (Fig. 3a), in the case of 6g NaCl, was lower when seeds were not exposed to heat shock than when a shock was imposed on the 1st, 2nd or 3rd days after sowing. This trend, although also detected in the 4g NaCl treatment, was not statistically significant in the latter. No significant differences were observed between the FGP of seeds at one particular treatment when combined with the four shock scenarios (Fig. 3a). The MGT was also not affected by treatment (shock combinations (Fig. 3b), but the GI of dry, untreated seeds dropped as heat shock was administered (Fig. 3c). The greatest drop in GI was observed when untreated seeds were shocked on the first day after sowing. Salt-treated seeds, on the other hand, were either unaffected by shock (in the case of 2g NaCl) or their GI increased as shock was applied (in the case of 6g NaCl) as observed in Figure 3c. Similar behaviour was noted in the DWP. Dry, untreated seeds not exposed

to shock attained a DWP of 2.4 mg, whereas when shock was applied on the first day after sowing, this dropped to 0.7 mg (Fig. 4a). Seeds treated with 2g *NaCl* gave 3.2 mg DWP values when non-shocked and 4.4 mg when shocked on the first day after sowing, whereas 6g *NaCl* yielded 2.3 mg and 2.2 mg values, respectively (statistically insignificant differences) (Fig. 4a).

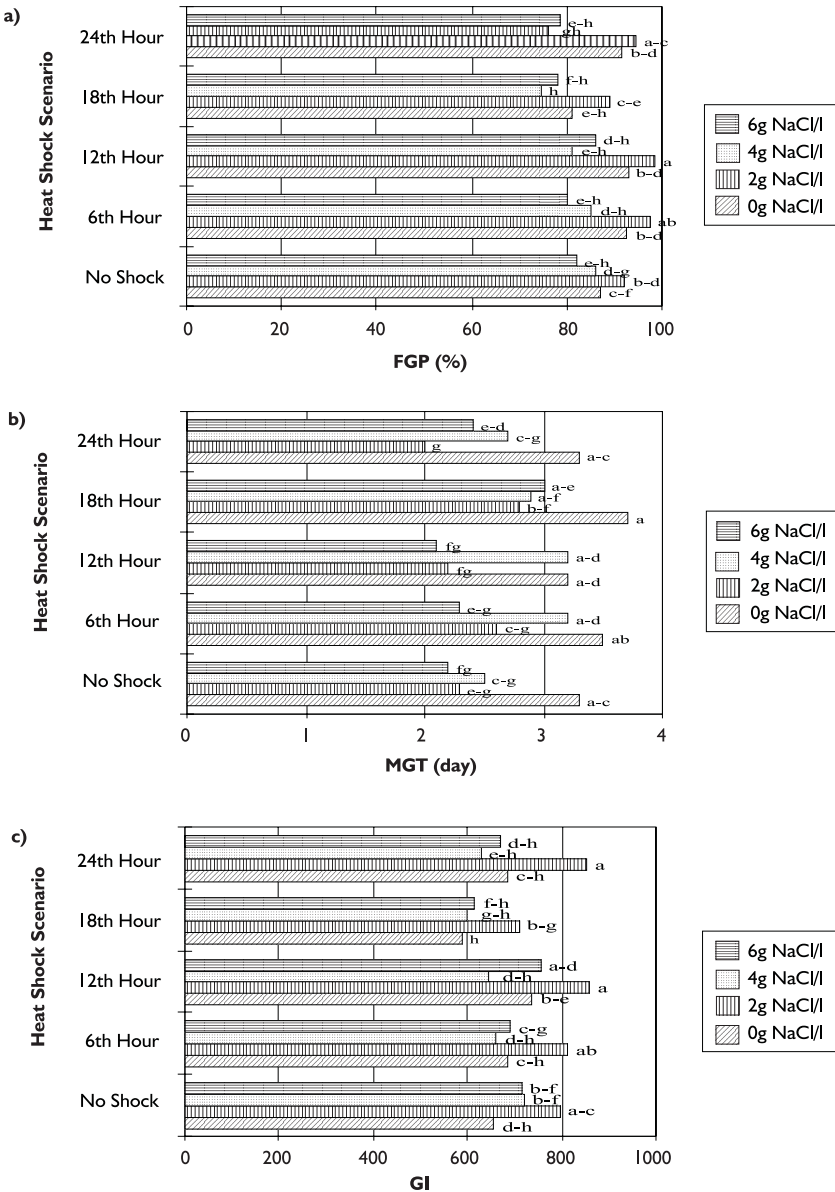
The DWR was modified by seed treatment and heat shock in another way. Here, dry, untreated seeds responded to shock by increasing growth (and thus the dry weight) of plumules. This increase as a response to heat shock was observed in all four seed treatments at all three heat shock timings (Day 1, 2 or 3) as illustrated in Figure 4b. There were, however, no significant differences in the DWP between heat shock timings themselves except in two cases. Seeds treated with 2g *NaCl* exhibited their highest DWR when shocked on Day 1, whereas 6g *NaCl*-treated seeds gave the highest DWR when shocked on Day 2 (Fig. 4b). Though not always significantly, the greatest drop in the PRR was observed when seeds were shocked on the first day after sowing (Fig. 4c). This drop was statistically significant in untreated and 6g *NaCl*-treated seeds, and meant that heat shock caused a change in the balance of shoots and roots in favour of the latter.

In this investigation, *NaCl*-based seed treatments increased the speed of germination, the DWP and the DWR. The 2g *NaCl* treatment gave the highest FGP and GI, but no differences were detected between seed treatments regarding the PRR.

In previous work (KADER, M., 2001; KADER, M. and JUTZI, S., 2001), the most sensitive period to heat stress was determined to be the second day after sowing. Thus, in this investigation, heat shock was applied at four different times within this second day in an attempt to pin-point the most susceptible period during this phase. Results revealed that the timing (between the 6th and 24th hour of the second day after sowing) of heat shock did not clearly affect germination or seedling growth in a stepwise manner. Rather, the 18th hour of the second day yielded lower FGP and GI values than the 6th or 12th hour but not lower than the 24th hour. In outlining the phases of germination in such a way, it is assumed that susceptibility to heat stress in sorghum seeds starts at or after the 18th hour on the second day after sowing. However, "pure" heat stress applied without drought ($\Psi_s = 0$ bar) is different from a combined water deficit/ high temperature stress. Here, heat shock (45°C) was accompanied by a -10 bar drought stress. Water and temperature interact, such that a seed threshold water potential, for example, depends largely on temperature and *vice versa* (AL-MUDARIS and JUTZI, 1998b; KADER, M. and JUTZI, S., 2001).

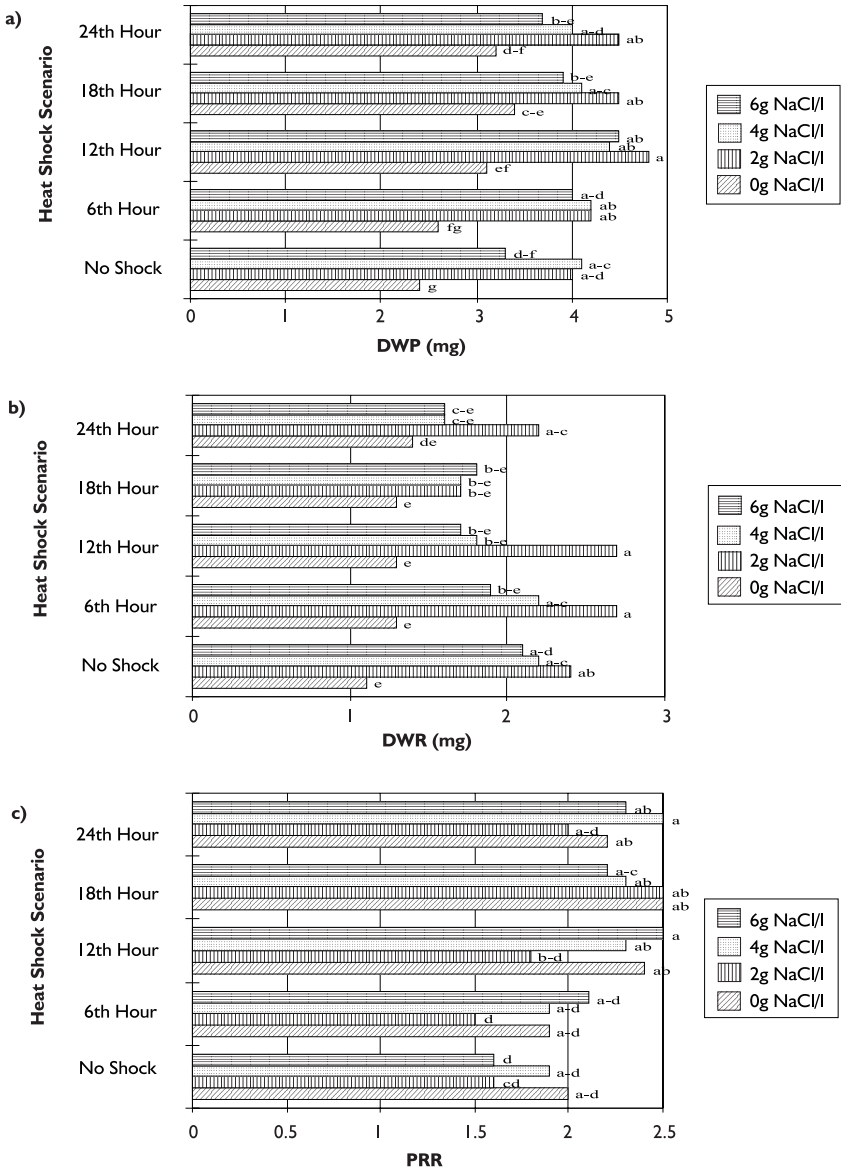
When heat shock was imposed on the first, second or third days after sowing (accompanied by -10 bar drought stress) the most sensitive phase, in terms of the GI, was not the second day (AL-MUDARIS and JUTZI, 1998c), but rather the first day. We suspect, then, that once exposed to combined stresses, the sensitivity of a seed to the environment is realised earlier in its seed-bed life cycle than when heat alone or drought alone are imposed upon it. This may be due to the fact that drought affects certain enzymes (e.g. glutamine synthetase essential for germination) in another way than heat stress (SUN, W. and LIANG, Y., 2001).

Figure 1: Interactive effects of seed treatment and heat shock scenarios on (a) the final germination percentage (FGP), (b) mean germination time (MGT) and (c) germination index (GI) of sorghum CSV 15 seeds



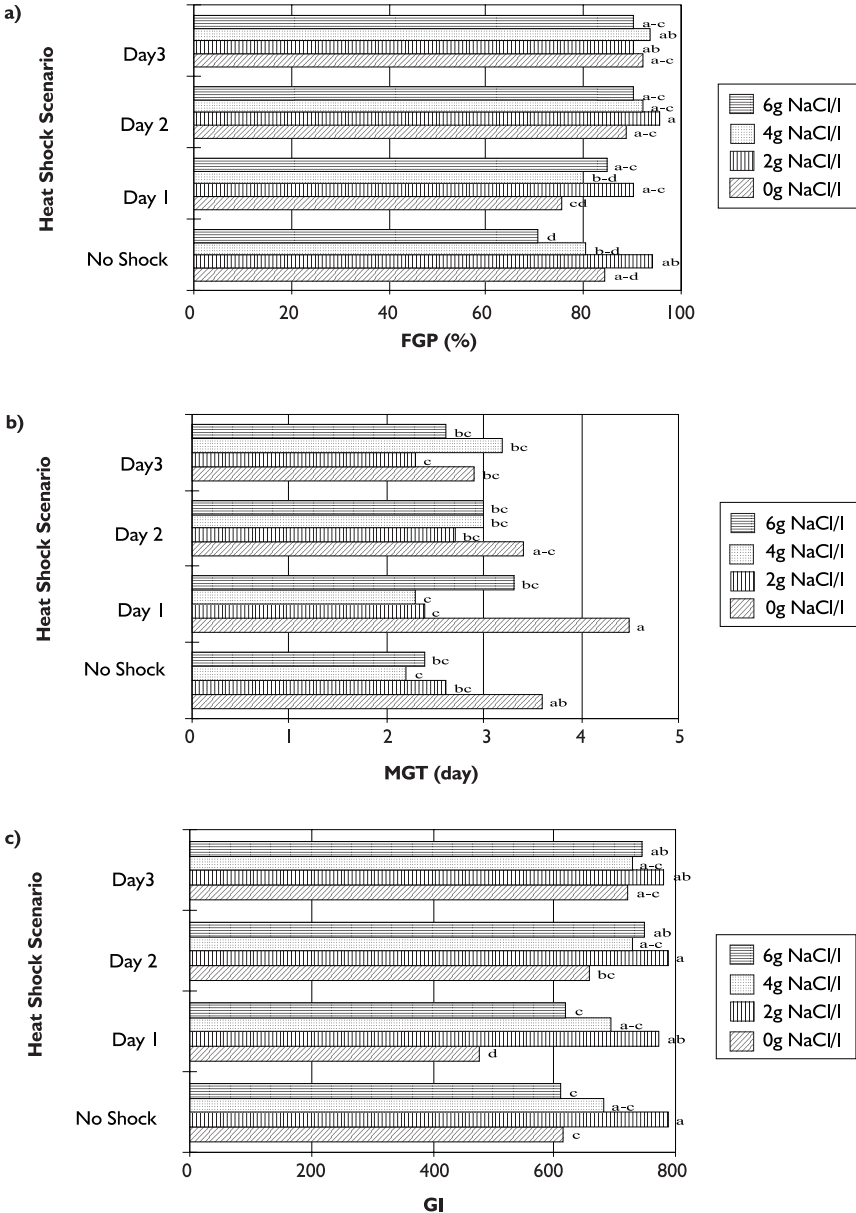
Bars having similar letters represent means that are not significantly different according to Duncan's Multiple Range Test ($p \leq 0.05$).

Figure 2: Interactive effects of seed treatment and heat shock scenarios on (a) the dry weight of plumule (DWP), (b) dry weight of radicle (DWR) and (c) plumule:radicle ratio (PRR) of sorghum CSV 15 seedlings



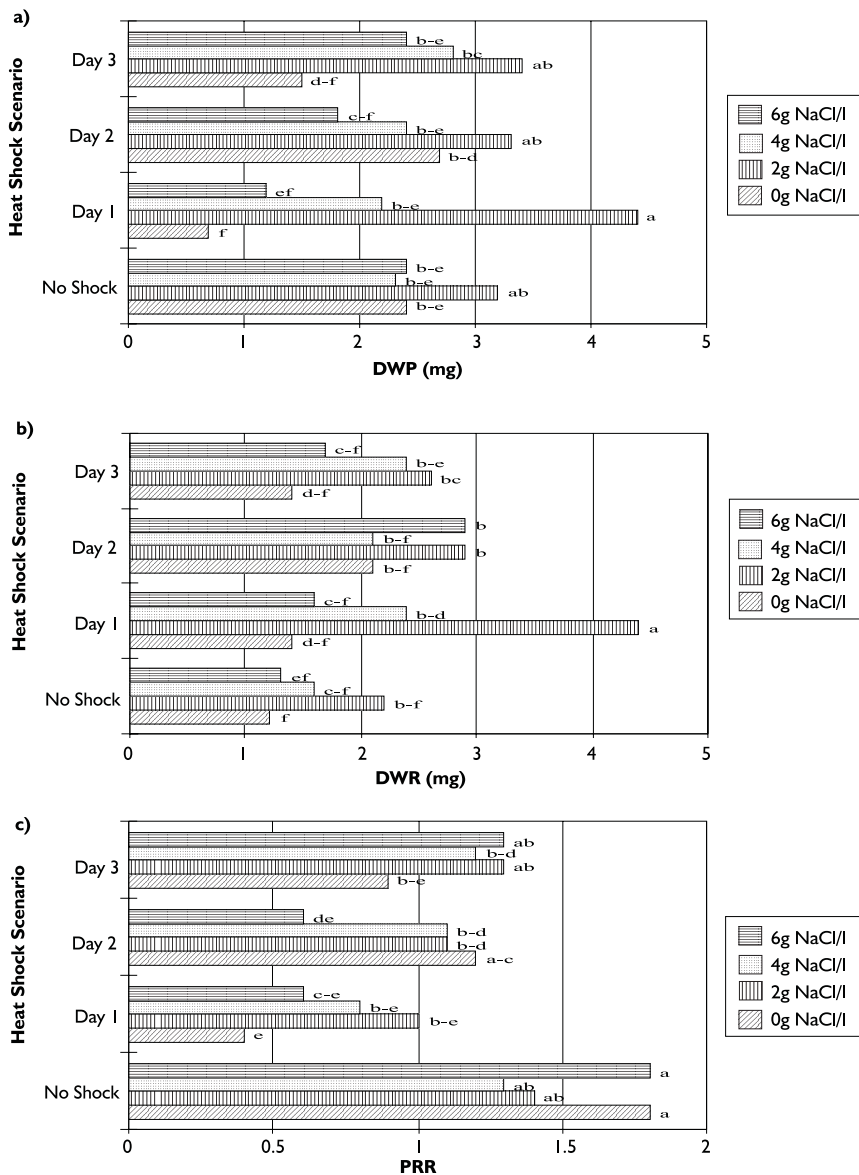
Bars having similar letters represent means that are not significantly different according to Duncan's Multiple Range Test ($p \leq 0.05$).

Figure 3: Interactive effects of seed treatment and heat shock scenarios during the first three days after sowing on (a) the final germination percentage (FGP), (b) mean germination time (MGT) and (c) germination index (GI) of sorghum CSV 15



Bars having similar letters represent means that are not significantly different according to Duncan's Multiple Range Test ($p \leq 0.05$).

Figure 4: Interactive effects of seed treatment and heat shock scenarios during the first three days after sowing on (a) the dry weight of plumule (DWP), (b) dry weight of radicle (DWR) and (c) plumule: radicle ratio (PRR) of sorghum CSV 15



Bars having similar letters represent means that are not significantly different according to Duncan's Multiple Range Test ($p \leq 0.05$).

Such an interaction, where germination differs at a fixed drought level with differing temperatures or *vice versa*, has been reported for other species (DE CASTRO *et al.*, 2000; TIGABU, M. and ODEN, P., 2001). The timing of susceptibility or tolerance to heat stress is, thus, apparently affected by such an interaction.

Genotypic differences in maximum percentage germination at high temperature have been proposed to be best detected after 24 h of sowing (JOHNSTON, M. *et al.*, 2002). It is also suggested that seeds are more sensitive to high temperature during the first 12 h of the first day after sowing than the second 12 h. This timing is highly correlated with the formation of Heat Shock Proteins within the seed (JOHNSTON, M. *et al.*, 2002). HOWARTH, C. (1989) documents that a characteristic set of heat shock proteins (HSPs) is synthesized as a result of sudden high temperature stress, whereas "normal" proteins are synthesized in decreased amounts or cease to be synthesized. He described two major categories of HSPs; high molecular weight (HMW) proteins, greater than 60 kDa in size, and low molecular weight (LMW) proteins, less than 30 kDa in size. Sorghum seeds (HOWARTH, C., 1989) are able to synthesize HSPs during the first 8 h of imbibition. The involvement of RNA (which is also heat-sensitive) in such a phenomenon has also been established (HOWARTH, C., 1990). As a result, we propose the whole 24-42 h phase of germination to be sensitive to heat, or heat + drought stress. Although hydro priming (osmotic treatment) has been reported to increase tolerance of seeds to high temperature (CHENG and BRADFORD, 1999) and alleviate thermodormancy (LIMA, W. *et al.*, 2001), its effectiveness under non-stress conditions depends on other factors. Part of the alleviating effect may come from the fact that seed priming involves biochemical or biophysical processes leading to a rejuvenated and enduring seed population (WARREN, J. and BENNETT, M., 1999). In sorghum, the response to *NaCl* seed treatments under heat stress is such that the greater the stress (in this case heat), the lower the reduction in germination caused by *NaCl* (KADER, M., 2001). Therefore, the reasons for lower FGP values under non-shock conditions can be understood. The relationship between radicle growth, PRR and stress, yielded interesting observations in this investigation. The DWR values of non-shocked seeds were lower than those shocked on the first and second days after sowing, thus confirming our earlier speculation that one of the seed's responses to stress is manifested in producing larger radicles (later on larger root systems).

Practical considerations in the field should take into account not just the timing of a "sensitive" phase to heat, but the level of drought in the soil, since, at a wide temperature range, germination, which is influenced by temperature, is retarded by rises in the osmotic potential (DE CASTRO *et al.*, 2000). Also, increasing the supply of water in the field under heat conditions can restrict the supply of oxygen that is necessary for germination. Oxygen is sparingly soluble and its solubility decreases with increasing temperature, whereas the metabolic demand for this gas increases with temperature (BENJAMIN, 1990).

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Effect of Cover Crops, Lime and Rock Phosphate on Maize (*Zea mays* L.) in an Acidic Soil of Northern Guinea Savanna of Nigeria

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Abstract

Phosphorus deficiency is the major constraint to maize production in acidic soil of Heipang (9°38', 8°53') in Northern Guinea Savanna of Nigeria. The soil is high in sesquioxides and soluble aluminum and has high phosphate sorption capacity. To address this problem, a field trial was conducted between 1996-1997 to assess the responses of six tropical cover crops and maize to lime and applied rock phosphate and to evaluate the effect of these treatments on the performance and P nutrition of succeeding maize. Results of the trial showed that planting *Chamaecrista rotundifolia*, *Lablab purpureus*, *Mucuna pruriens*, and maize-*Chamaecrista rotundifolia* intercrop reduced the leaf Al concentration of succeeding maize by more than 38%. Although none of the six cover crops significantly increased grain yields of succeeding maize, *C. rotundifolia* was the most consistent in improving maize performance while *Glycine max* produced the least performance. Concentration of *Mn* in the index leaves of maize was significantly higher on plots where *G. max* preceded maize, thus accounting for the poor performance of maize on these plots. Application of Sokoto Phosphate Rock at 30 kg ha⁻¹ to cover crops produced very significant improvement in the yields of succeeding maize. While liming with 1.35 t *CaO* ha⁻¹ in 1997 raised the soil pH value by 0.2 and significantly improved total P uptake by maize.

Keywords: P deficiency, rock phosphate, liming, cover crops, maize yield

1 Introduction

About 1.8 billion hectares of land, representing one-third of the total land area in the tropics, have strong enough soil acidity for soluble aluminum to be toxic to most crop species (SANCHEZ, P. A. and LOGAN, T.J., 1992). According to NICHOLAIDES, J. J. *et al.* (1983) as reported by OGUNTOYINBO, F. I. *et al.* (1996), acid soils cover about 17 million hectares of land in Nigeria. In the southern region and some areas of the middle belt high levels of sesquioxides; toxic levels of soluble *Al* and *Mn*; and deficient levels of phosphorus cause severe limitations to soil productivity (UDO, E.J. and UZO, F.O., 1972; MOKWUNYE, A. *et al.*, 1986; JIBRIN, J. M., 1999). There is no evidence that any tropical plant species of agricultural importance are adapted to all

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factors of acid soil infertility. The general practice for correcting soil acidity and nutrient deficiency especially of *P* is by lime and *P* fertilizer application respectively. However, in Nigeria where several factors limit the use of inorganic *P* fertilizers (most of which are imported), the key to sustainable food production in low activity clay soils with high *P* sorption capacity and low organic matter content is the development of a cropping system that makes greater use of locally-sourced inputs. Important components of such a strategy include greater sourcing and use of locally available rock phosphates; choice of *P* efficient and *Al*- and *Mn*-tolerant plant species, and the proper management of soil organic matter through green manuring, cover cropping and return of crop residues. HORST, W. J. (1992) described this approach as a “low external input high efficiency strategy”. The objective of this study was to evaluate the effect of lime and phosphate rock application to cover crops on subsequent maize growth, yield and *P* uptake in acidic soil in Nigeria. The role of some tropical cover crops in reducing the impact of soil acidity on succeeding food crops was also examined.

2 Materials and methods

2.1 Study area

The experiment was conducted on a Typic Plinthustult at Heipang (9°38', 8°53'), Northern Guinea Savanna of Nigeria during the 1996 and 1997 cropping seasons. The soil has high contents of *Fe*, *Al* and *Mn* oxides, with very high *P* fixing capacity. Characteristics of the soil are presented in Table 1.

2.2 Experimentation

The experiment was initiated in 1996 in a split-split plot design with 4 replications. The sub-sub plots of 4 × 5.25 m² comprised of 0 kg *P* ha⁻¹, 30 kg *P* ha⁻¹ in form of Sokoto Phosphate Rock (SPR), and 30 kg *P* ha⁻¹ in form of Single Superphosphate (SSP). The sub plots measuring 4 × 13 m² received 0 and 250 kg *CaO* ha⁻¹. The main plots of 13 × 11 m², had the following crop treatments:

1. *Zea mays* L. (crop residue removed after grain harvest)
2. *Zea mays* L. (crop residue incorporated into soil after grain harvest)
3. *Phaseolus vulgaris*
4. *Cajanus cajan*
5. *Glycine max*
6. *Chamaecrista rotundifolia*
7. *Lablab purpureus*
8. *Mucuna pruriens*
9. *Zea mays* L. intercropped with *Chamaecrista rotundifolia*
10. *Zea mays* L. intercropped with *Cajanus cajan*

All maize plots received urea at the rate of 120 kg *N* ha⁻¹ in split doses, half at planting and the rest 6 weeks later. The legumes were given a maintenance dose of 20 kg *N* ha⁻¹ at 5 weeks after planting. All plots were treated with 50 kg *K* ha⁻¹ in form of *KCl*. At the end of the growing season all the crop residues were incorporated into the soil after seed harvest, except in treatment 1 above.

Table 1: Characteristic of Heipang soil

Soil Property	Value
Clay	520 g kg ⁻¹
Sand	240 g kg ⁻¹
Silt	240 g kg ⁻¹
Texture	Clay
pH (<i>H</i> ₂ <i>O</i> ; 1:2.5 w/v)	5.4
pH (0.01m <i>CaCl</i> ₂ ; 1:2.5 w/v)	4.4
Total <i>P</i>	473 mg kg ⁻¹
Bray 1 <i>P</i>	0.69 mg kg ⁻¹
Anion resin extractable <i>P</i>	2.03 mg kg ⁻¹
Water soluble <i>Al</i> *	23.2 mg kg ⁻¹
Organic <i>C</i>	13.0 g kg ⁻¹
Total <i>N</i>	1.6 g kg ⁻¹
CEC	16.3 Cmol kg ⁻¹
Exchangeable acidity	0.9 Cmol kg ⁻¹
Exchangeable <i>Al</i>	0.6 Cmol kg ⁻¹
Free oxides (CBD method)	
<i>Fe</i>	61.8 g kg ⁻¹
<i>Al</i>	7.5 g kg ⁻¹
<i>Mn</i>	0.4 g kg ⁻¹

* water soluble *Al* was determined after shaking 1g soil in 60ml water for 16 hours

During the 1997 cropping season, the sub-sub plots were further split into two with one half receiving a fresh P treatment of 60 kg *P* ha⁻¹ in form of SSP. Additional 1.35 t *CaO* ha⁻¹ based on the soils liming requirement was applied to all previously limed plots to maintain the pH at around 5.5. Maize (*Zea mays* cv. 8644-27) was the test crop on all plots. All plots were treated with 120 kg *N* ha⁻¹ in split doses as in 1996 and 50 kg *K* ha⁻¹ at planting.

2.3 Soil and plant tissue analysis

Plant and soil tissue analyses were carried out according to the procedures documented by J_UO, A.S.R. (1979).

2.4 Statistical analysis

All the data collected were subjected to analysis of variance (ANOVA) using the GEN-STAT V package for statistical analysis (LAWES AGRICULTURAL TRUST, 1993).

3 Results and discussion

3.1 Grain and stover yields

Maize grain yield response to preceding cover crop treatments and lime application in 1997 was not statistically significant (Figs. 1&2b). Although not statistically significant

the results also showed that *G. max* depressed maize grain yield. Application of both SPR and SSP in 1996 produced significant maize grain yield increases in 1997, with SSP being superior to SPR. The ability of SPR to significantly increase maize grain yield on this soil confirms its suitability on soils with low available *P* content. Fresh application of 60 kg *P* ha⁻¹ in 1997 produced about 130% increase in grain yield. There were significant interaction effects of 1996 and 1997 *P* treatments on grain yields, with plots treated with SSP in 1996 and fresh 60 kg *P* ha⁻¹ in 1997 producing the highest yields. This indicates that even the application of 60 kg *P* ha⁻¹ was not sufficient enough to give maximum yield on this soil.

Maize stover yields were significantly raised where maize was preceded by *C. rotundifolia*, *C. cajan*, maize intercropped with *C. cajan*, and maize intercropped with *C. rotundifolia* (Fig. 1). *Glycine max* produced the least amount of stover. Effect of liming on stover yield was not obvious (Fig. 2). Both 1996 and 1997 phosphate application produced significant maize stover yield increases in 1997.

3.2 Tissue nutrient contents

Preceding crops had no significant effect on *P* concentration of maize index leaves at 50% flowering, nor on total *P* uptake at harvest (Fig. 1). Application of lime significantly raised the *P* concentration of index leaves and the total *P* uptake. Both SSP and SPR application in 1996 and fresh *P* application in 1997 resulted in significant increases in tissue *P* concentration and total *P* uptake.

Magnesium concentrations of maize index leaves at 50% flowering were significantly ($P = 0.05$) raised where *C. rotundifolia*, *M. pruriens*, *P. vulgaris* and maize intercropped with *C. rotundifolia* preceded maize (Table 2). *Glycine max*, on the other hand, significantly lowered *Mg* and raised *Mn* contents of index leaves of succeeding maize. This explains the lower performance of maize observed on plots preceded by *G. max*. *Glycine max* tended to accumulate toxic levels of *Mn* in its tissue, and indeed *Mn* toxicity symptoms were observed on the leaves of the plant during growth. This high level of *Mn* must have been released in to the soil solution upon decomposition of the crop residue, thus raising the level of *Mn* taken up by succeeding maize.

Although statistically, the *Al* concentrations of maize index leaves were not significantly lowered by preceding crop treatments, there were 42.2, 41.4, 39.1, and 38.4% reductions in *Al* concentrations where maize was preceded by *M. pruriens*, maize-*C. rotundifolia*, intercrop, *L. purpureus* and *C. rotundifolia* respectively. This indicates the ability of some crop residues in lowering the concentrations of *Al* in soil and reducing the impact of soil acidity. Similar effect was reported by KRETZSCHMAR, R.M. *et al.* (1991) who observed more than 44% decrease in total and labile *Al* concentrations in the soil solution of an acid Psammentic Paleustalf in Niger republic after incorporating millet residue.

Liming significantly raised the concentrations of *Ca* and *Mg* and lowered the *Mn* concentrations of index leaves (Table 3).

3.3 Soil and available P

At the beginning of 1997 season (before application of fertilizers and lime) the effects of 1996 treatments did not manifest on available (Bray 1) P. The values for available soil P were extremely low, ranging from 0.5 to 1.44 mg kg⁻¹ soil. At mid-silking, effects of preceding crops, liming and 1996 P treatments did not also significantly influence the concentration of available P in soil (Figs. 1&2). However, the application of 60 kg P ha⁻¹ in 1997 significantly increased the concentration of Bray 1 P from 0.44 to 1.73 mg kg⁻¹. The extremely low concentration of available soil P even with the application of 60 kg P ha⁻¹ in 1997 further confirms the very high P sorption capacity of this soil. The mean effects of the liming on soil pH at mid-silking showed that lime application raised soil pH by 0.2. The effects of preceding crops and phosphate application on soil pH were not evident.

Table 2: Effect of preceding crops on nutrient element concentrations in index leaves of maize at 50% silking in 1997

Preceding crop	<i>Al</i> mg kg ⁻¹	<i>Mn</i> mg kg ⁻¹	<i>Fe</i> mg kg ⁻¹	<i>Mg</i> g kg ⁻¹	<i>Ca</i> g kg ⁻¹
Maize-residue	151	33.44	109	2.53	4.00
Maize + residue	117	38.17	104	2.60	4.00
Maize + <i>C. rotundifolia</i>	89	36.5	103	2.87	4.23
Maize + <i>C. cajan</i>	111	35.05	106	2.51	4.01
<i>G. max</i>	169	41.16	116	2.27	3.54
<i>C. rotundifolia</i>	93	34.40	105	2.93	4.38
<i>L. purpureus</i>	92	33.05	101	2.73	4.13
<i>M. pruriens</i>	87	32.35	101	2.81	4.11
<i>P. vulgaris</i>	109	38.00	104	2.81	4.08
<i>C. cajan</i>	104	31.19	105	2.63	4.16
F ratio	ns	*	ns	**	ns
SE±	-	3.811	-	0.86	-
%CV	-	10.80	-	5.1	-

Table 3: Effect of liming on nutrient element concentrations in index leaves of maize at 50% silking in 1997

Treatment	<i>Al</i> mg kg ⁻¹	<i>Mn</i> mg kg ⁻¹	<i>Fe</i> mg kg ⁻¹	<i>Mg</i> g kg ⁻¹	<i>Ca</i> g kg ⁻¹
Unlimed	107	38.61	104	2.60	3.83
Limed	118	32.06	107	2.73	4.29
F ratio	ns	**	ns	*	**
SE±	-	4.971	-	0.287	0.435
%CV	-	14.1	-	10.7	10.7

Figure 1: Effect of preceding crops on maize yields, *P* contents and available soil *P* and pH in 1997

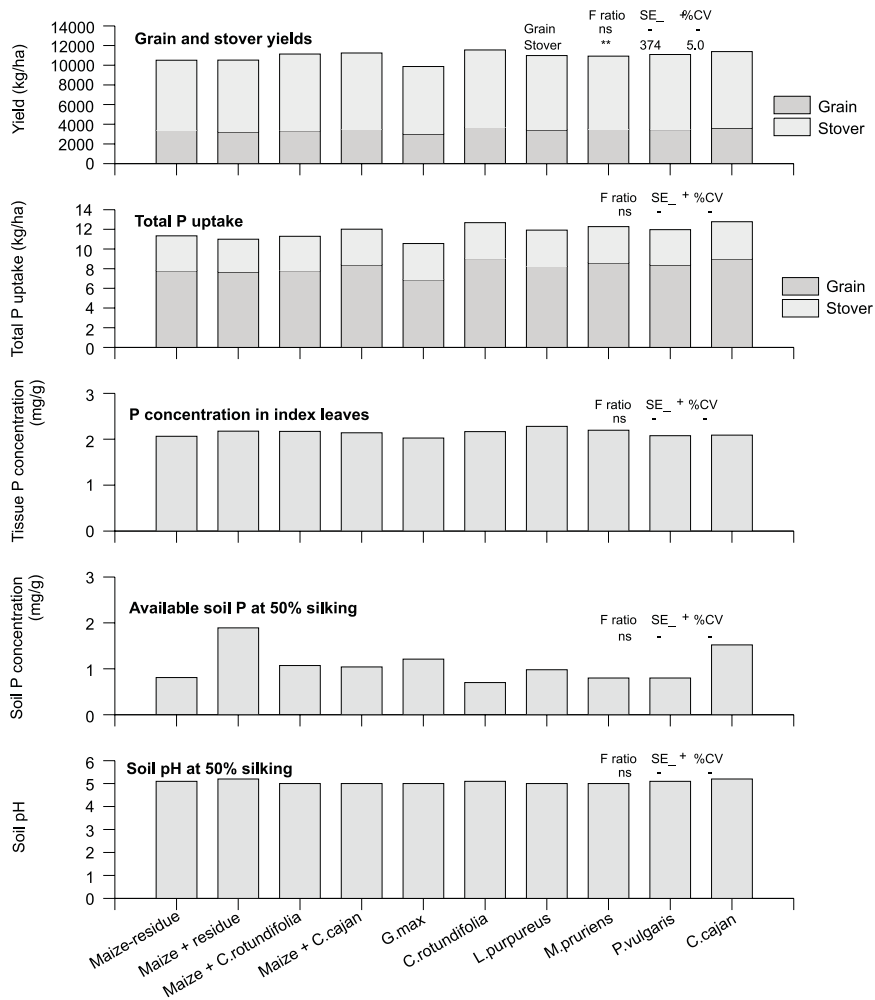
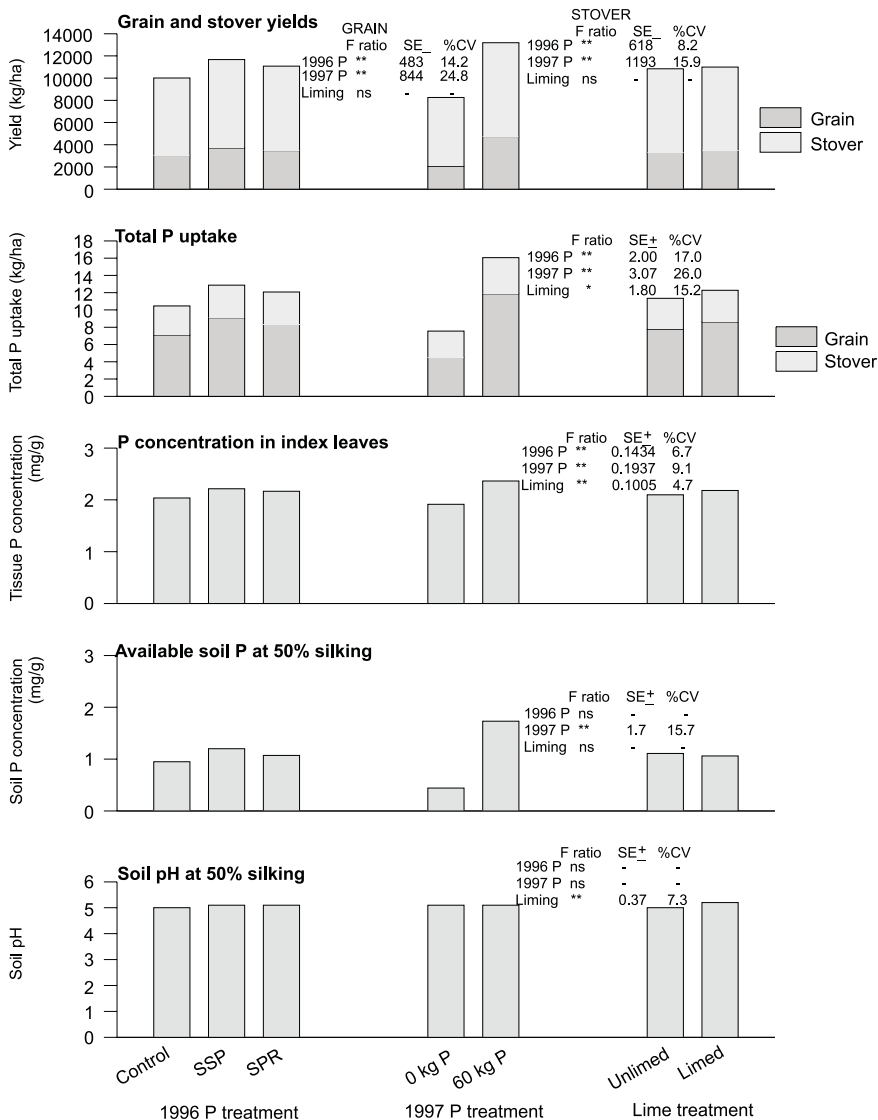


Figure 2: Mean effect of P treatments and liming on maize yields, P contents and available soil P and pH in 1997



4 Conclusion

The *P* uptake of maize on a Typic Plinthustult with high *P* sorption is significantly improved with liming. Application of SPR to cover crops could produce significant yield increases in succeeding maize. Planting *C. rotundifolia*, *L. purpureus*, *M. pruriens* and maize-*C. rotundifolia* intercrop could reduce the impact of soil acidity on succeeding maize by reducing the amounts of *Al* and *Mn* taken up by maize while *G. max* may exacerbate the problems of acidity.

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Phosphorus Availability Studies on Ten Ethiopian Vertisols

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Abstract

Three chemical extraction methods (Olsen, Truog, and Warren and Cooke) were earlier recommended for soil available *P* determination on Ethiopian soils. In the present study, the applicability of these methods and two others (Bray II and CAL methods) on ten Ethiopian Vertisols was tested using durum wheat and chickpea, which are traditional Vertisol crops in Africa. Results showed that the magnitude of soil available *P* extraction was in the order Truog > CAL > Olsen > Bray II > Warren and Cooke. The four methods excluding the CAL were highly significantly ($P < 0.001$) correlated with each other and also with crop *P* uptake. The CAL method was also correlated with most of the parameters, but the significance was not as high as that with the other extraction methods. The highest correlation was also obtained between wheat *P* uptake and the four extraction methods. None of the correlations involving dry matter yield were significant. Based on the results it can be generalized that wheat is a better indicator for *P* availability than chickpea. The results also show that the earlier recommended three methods are applicable to Vertisols and each method may be used in substitution of the other (with the exception of the Warren and Cooke method, the applicability of which on high pH soils may be limited) in case of need. Due to the shortage of chemicals often encountered in soil laboratories in Ethiopia, the need for testing multi-element extraction methods is recommended.

Keywords: Available *P*, Ethiopian soils, Vertisols

1 Introduction

In Ethiopian agriculture, Vertisols or cracking clay soils have an important place since they are widely distributed (over 12 m ha) and have diverse chemical properties. A multidisciplinary Joint Vertisol Management Project has been in operation in Ethiopia since 1986 (MAMO *et al.*, 1993) in order to improve the productivity of these soils.

Next to nitrogen, phosphorus is often the limiting nutrient for crop production in tropical soils. In soil phosphorus availability studies, the selection of an appropriate methodology is a key factor. In Ethiopia, the Olsen's $NaHCO_3$ method (OLSEN *et al.*, 1954) is often used for determining soil available *P*. In a recent study, MAMO and HAQUE (1991) reported that the Olsen, Warren and Cooke, and Truog methods were the best of the eight chemical methods they used to assess available *P* on 32 Ethiopian soils. The

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Ethiopian Society of Soil Science has discussed the need for standardizing methodologies and as a first attempt decided that until such time that *P* calibration studies are made the Olsen method (and any other additional method if laboratories feel the need for a second method) should be used to determine available *P* on Ethiopian soils.

Most Ethiopian soils including Vertisols are deficient in *P* when assayed by chemical methods; yet, with the addition of *P* fertilizers, field crop *P* responses on these soils, particularly in the central highlands are low, even under improved drainage conditions (MAMO *et al.*, 1993). Several possible chemical and biological theories may be given for the poor response to *P* fertilizer, but this may be beyond the scope of this paper. Our objective in this study was to check the applicability of the Olsen, Warren and Cooke, Truog, Bray II and CAL methods to Vertisols collected from locations differing geographically and ecologically using two traditional Vertisol crops, durum wheat and chickpea.

2 Materials and methods

Ten Vertisol surface samples (0-30cm) were collected from various locations in Ethiopia representing diverse conditions (Table 1). The samples were air dried and sieved through a 2mm sieve. Selected physical and chemical properties of the soils were determined at the National Soil Service Laboratory in Ethiopia. These included soil pH in a soil-to-water ratio of 1:2.5, particle size distribution by the hydrometer method (BOUYOUCUS, 1951), organic matter by the dichromate oxidation method of WALKLEY and BLACK (1934), and exchangeable cations by the neutral 1N ammonium acetate leaching method. Exchangeable *Na* and *Mg* were determined by flame photometry while *Ca* and *Mg* were read on atomic absorption spectrophotometer.

Table 1: Some characteristics of the experimental soils

Soil no.	Location in Ethiopia	pH (H_2O) (1:2.5)	Clay (%)	Organic matter (%)	Exch. cations ($cmol(+)kg^{-1}$)			
					<i>Na</i>	<i>K</i>	<i>Ca</i>	<i>Mg</i>
1	Akaki	7.37	84	2.28	0.95	1.90	50.6	8.0
2	Alemaya	7.75	72	3.45	0.55	1.49	50.0	5.2
3	Bichena	6.66	81	2.72	0.55	1.39	43.2	8.4
4	Chefe Donsa	7.15	78	1.82	0.71	2.00	49.0	5.9
5	Debre Zeit	6.91	75	1.83	0.71	1.86	31.4	7.6
6	Debre Brhan	5.98	39	1.95	0.55	0.83	26.1	5.2
7	Ginchi	6.74	74	3.15	2.00	1.50	39.5	7.5
8	Sheno	6.23	56	3.09	0.53	0.80	29.1	5.7
9	Mekelle	8.25	61	2.71	0.98	1.20	45.8	4.7
10	Sholla	5.81	69	2.87	0.59	0.86	34.2	7.9

Available phosphorus in the soils was extracted by five chemical methods. They were Olsen's 0.5M $NaHCO_3$ (OLSEN *et al.*, 1954), 0.3N HCl (WARREN and COOKE, 1965), dilute H_2SO_4 buffered with $(NH_4)_2SO_4$ (TRUOG, 1930), the Bray II extractant

(BRAY and KURTZ, 1945), and the CAL method (SCHÜLLER, 1969). Description of these methods is given in Table 2. The first three methods were recommended for Ethiopian soils by MAMO and HAQUE (1991). The Bray II extractant was included because it is sometimes used by few laboratories in Ethiopia. The CAL method which is the standard in Germany and some parts of Europe, is not used in Ethiopia but it was included in this study for comparison purposes. In all cases, available *P* was determined on duplicate samples following the Murphy and Riley method (MURPHY and RILEY, 1962) using a Hitachi U-2000 Spectrophotometer.

Table 2: Chemical *P* extraction methods used

<i>Method</i>	<i>Reagent</i>	<i>Soil to solution ratio</i>	<i>Shaking time</i>
Olsen	0.5 M $NaHCO_3$, pH 8.5	1:20	30 min
Warren & Cooke	0.3N HCl	1:12.5	1 min
Truog	0.002N H_2SO_4 buffered with $(NH_4)_2SO_4$ at pH 3	1:200	30 min
Bray II	0.03N NH_4F in 0.1N HCl	1:7	1 min
CAL	0.05M calcium lactate + 0.05M calcium acetate + 0.3M acetic acid	1:20	90 min

For plant phosphorus uptake study, two experiments were conducted using durum wheat (*Triticum durum* Desf.) variety Kilinto and chickpea (*Cicer arietinum* L.) variety Mariye in a glass house which was maintained at a day/night temperature of 20/15°C, 60% relative humidity and 10,000 lux illumination for 12 hours in a day. 500g sieved soil and 200g nutrient free sand were weighed and mixed in 0.75kg capacity plastic pots. For the experiment with wheat, 15 seeds were planted which were one week later maintained to 10 per pot. Chickpea, on the other hand, was kept at a constant number of 8 from an initial number of 12. The treatments were replicated three times and arranged in a randomized complete block design. Wheat plants were fertilized with NH_4NO_3 (at the rate of 50 mg *N* per pot in three splits). No other fertilizer was applied to both crops.

Plants were grown for 35 days during which they were supplied with a measured quantity of rain water as often as necessary. By the time of harvest, some wheat plants had developed *P* deficiency (reddish brown stems and pale yellow leaves) while chickpea plants were normal. After harvest, the aboveground parts were oven-dried at 70°C and weighed. Samples were then ground using a tecator plant mill. For *P* determination by the yellow vanadomolybdate method, 0.2g sample was dry ashed at 550°C for 5 hours, diluted initially with 10ml concentrated HCl , and then with distilled water to 50ml. Data were analysed for statistical significance by computer using the SAS statistical package (SAS INSTITUTE, 1990).

3 Results and discussion

Soil available *P* values estimated by the five chemical extraction methods are given in Table 3. The order of magnitude of *P* extracted was Truog > CAL > Olsen > Bray II > Warren and Cooke. Consistently higher *P* was extracted by all the methods from soils number 4 (Chefe Donsa) and 5 (Debre Zeit). The two locations are research sites of the Debre Zeit Agricultural Research Center and the sites may have received more quantity of *P* fertilizer during the past years than the other locations. Unlike the other methods, the Warren and Cooke method extracted very little *P* from soil number 9 (which is a soil with the highest pH), thus indicating the limitation of the highly acid (pH<1) extractant on high pH soils.

Table 3: Soil available *P* extracted by different methods (ppm *P*)

<i>Soil no.</i>	<i>CAL</i>	<i>Olsen</i>	<i>Bray II</i>	<i>Warren& Cooke</i>	<i>Truog</i>
1.	19.59	10.65	9.39	5.68	37.58
2.	7.45	5.33	3.85	1.10	16.90
3.	10.47	7.76	3.53	1.72	8.70
4.	34.41	12.98	15.40	12.04	62.02
5.	43.08	23.50	22.20	23.94	102.18
6.	3.58	5.82	3.28	3.17	21.18
7.	9.94	9.23	5.24	2.99	11.34
8.	8.04	7.92	2.13	0.82	0.74
9.	41.11	10.10	8.64	0.01	14.94
10.	9.02	4.61	2.81	0.31	3.14
Mean	18.67	9.79	7.65	5.18	27.9

Table 4 shows the dry matter yield and *P* uptake data of the two crops. The soils' ability to supply *P* was different in both crops. For example, the yield of wheat was at its highest on soil number 5 (Debre Zeit), and it was significantly different from the yield obtained from soils 1, 8 and 9. The last two soils produced the lowest amount of dry matter. Chickpea, on the other hand, showed less sensitivity to soil *P* variation. This was also noted during the plant growth experiment since chickpea plants did not exhibit any *P* deficiency symptoms. From the dry matter yield data it is possible to note that variation existed between the two crops in terms of the highest and lowest yield obtained from the soils.

Wheat *P* uptake gave a better measure of the soils' variability in *P* status. Data presented in Table 4 show that soils 4 and 5 were the two soils from which there was the highest *P* uptake, while soil numbers 6 and 8 were the lowest. This agrees with the data given in Table 3. *P* uptake by chickpea was in most cases more than 2.5 times greater than wheat *P*, suggesting the presence of a possible mechanism in chickpea by which

Table 4: Shoot dry matter yield (g/pot) and *P* uptake (mg/pot) of wheat and chickpea plants grown on ten non-P-fertilized soils

Soil no.	Location	Wheat		Chickpea	
		Yield	<i>P</i> uptake	Yield	<i>P</i> uptake
1.	Akaki	0.74	1.07	1.47	3.72
2.	Alemaya	0.83	0.94	1.37	4.01
3.	Bichena	0.82	0.94	1.44	3.89
4.	Chefe Donsa	0.83	1.07	1.44	4.20
5.	Debre Zeit	0.91	2.22	1.43	3.19
6.	Debre Brhan	0.75	0.88	1.33	3.79
7.	Ginchi	0.84	0.92	1.36	3.33
8.	Sheno	0.70	0.68	1.25	3.52
9.	Mekelle	0.68	0.95	1.39	3.98
10.	Sholla	0.82	0.97	1.17	3.10
	LSD _(0.05)	0.117	0.292	0.118	0.439

it may acquire more available *P* from the soils. This finding is also in agreement with previous studies which indicated that chickpea did not respond to *P* fertilizer application on Vertisols (MAMO *et al.*, 1993).

The comparisons in Table 5 show that there were fairly good relationships between the *P* extraction methods. The CAL method was the least in terms of magnitude of significance of its correlation with the others, probably because the extracted *P* values were not very different among the soils when compared with the other methods. The higher correlation values ($P < 0.001$) between the other methods indicate that substitutions could be made in the methodologies in case of need; the only exception may be the Warren and Cooke method which did not extract any amount of *P* from soil number 9 (high pH soil).

When crop *P* uptake was correlated with soil available *P* values, significant correlations were found with all methods. Although correlations between crop dry matter yield and soil available *P* extracted by all the methods were positive, none of them reached the significance level indicating that yield limiting nutrients other than *P* may have also been involved. This result also shows that crop yield alone may not be a good indicator of the best soil available *P* extractant. However, the correlations became significant when computation was made between crop *P* and the four methods of *P* extraction. Interestingly, the highest correlations were found between wheat *P* uptake and the four methods of *P* extraction. The correlations with chickpea *P* uptake were only significant at the 5% significance level, whereas correlation with wheat *P* was significant at 0.1% for the three methods (Olsen, Warren and Cooke, Truog), 1% for the Bray II method, and 5% for the CAL method. The highly significant correlations between wheat *P* uptake and the three *P* extraction methods support previous reports

Table 5: Correlation coefficients between crop dry matter yield, *P* uptake and soil available *P* values

	Warren& Cooke	Olsen	Truog	Bray II	CAL	Wheat yield	Wheat <i>P</i>	Chickpea yield
Olsen	0.936***							
Truog	0.978***	0.916***						
Bray II	0.935***	0.947***	0.965***					
CAL	0.655*	0.799**	0.723*	0.865**				
Wheat yield	0.624	0.453	0.553	0.471	0.122			
Wheat <i>P</i>	0.917***	0.900***	0.891***	0.862**	0.648*	0.653*		
Chickpea yield	0.458	0.522	0.551	0.568	0.503	0.179	0.390	
Chickpea <i>P</i>	0.718*	0.719*	0.789*	0.766*	0.689*	0.305	0.672*	0.709*

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

about the superiority of these methods in Ethiopian soils (MAMO and HAQUE, 1991). It can also be generalized that wheat gives a better indication of soil available *P* status when related with chemical methods than chickpea, which is known to thrive well under marginal soil fertility conditions.

4 Conclusion

As indicated earlier, Vertisols are important soils which are given priority in the present day agricultural activity of Ethiopia. Their wide distribution and variability also justify the attempt for determining the most suitable *P* availability estimation on this group of soils. In line with this, MURIUKI and BARBER (1983) have also examined the merits of separating tropical soils into groups and using different chemical extractants for different groups in the routine determination of soil available *P*. The confirmation of the applicability of the three previously recommended methods on these soils is useful when flexibility in the use of methodologies is often necessary, mainly due to shortage of laboratory chemicals (which at present are all imported) often encountered in Ethiopia. In this regard, the possibility of testing the use of multi - element extractants for the routine determination of soil available *P* and other elements (such as *K*, *Ca*, *Mg*) is encouraged since it is speedy and economical.

Moreover, researchers may direct their emphasis towards studying the causes of poor *P* response by crops or investigating the mechanisms by which traditional Vertisol crops are adapted to low soil *P* conditions rather further attempting to find the best chemical extractants for soil available *P*. However, all the findings from controlled environment studies need to be confirmed under field conditions, and determination of the critical soil *P* values for the major crops is necessary.

5 Acknowledgements

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Eckhard Baum, Witzenhausen

Benzing, Albrecht; 2002

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inhaltlichen Dichte ist es sehr übersichtlich gestaltet und reich mit Tabellen und Schaubildern versehen. Besonders lesenswert sind auch die abschließenden Ausführungen zu den Chancen und Möglichkeiten des nach internationalen Richtlinien zertifizierten Ökolandbaus für die kleinbäuerliche Landwirtschaft der Anden.

Bei der Fülle des aufgearbeiteten Materials hätte man sich vielleicht noch etwas mehr eine kritische Beurteilung von Widersprüchen gewünscht, die bei den zitierten Untersuchungen unter verschiedenen Umweltbedingungen zwangsläufig auftreten. Für Leser, deren berufliche Tätigkeit im Übergangsbereich zwischen landwirtschaftlicher Praxis und der theoretischen Weiterentwicklung der Ökologischen Landwirtschaft liegt, wäre am Ende auch eine Zusammenfassung hilfreich gewesen, in der zukünftige Fragestellungen für die Forschung im Ökologischen Landbau klar benannt worden wären. Insgesamt betrachtet, schließt das Buch durch seine fachliche Breite und Tiefe eine oft bemerkte Lücke in der anwendungsorientierten, wissenschaftlichen Literatur zum Ökologischen Landbau. Dazu tragen auch das umfangreiche Sachregister und das vorzügliche Literaturverzeichnis bei. Zu hoffen bleibt, dass das Werk in nicht allzu ferner Zukunft auch in englischer Sprache erscheinen kann und damit über den andinen Leserkreis hinaus die Verbreitung findet, die es verdient.

Andreas Bürkert, Witzenhausen

Pohlan, Jürgen (Herausgeber); 2001

La fruticultura orgánica en el Cauca, Colombia - Un manual para el campesinado
326 Seiten, 55 Tabellen, 47 Abbildungen und Schemata, 2 Farbseiten, spanisch, Shaker Verlag Aachen, ISBN 3-8265-8904-1, € 26,59

Der organische Obstbau erlangt auch in den Tropen zunehmend an Bedeutung. Eine praktische und wissenschaftliche Anleitung und Begleitung dieser Wachstumsdisziplin steckt noch in den Kinderschuhen. Deshalb können die Marktchancen nur unzureichend genutzt werden und eine nachhaltige Entwicklung kommt nur langsam voran. In Kolumbien steht zusätzlich die Ablösung drogenliefernder Kulturen durch andere marktorientierte Nutzpflanzenarten zur Debatte.

Vorliegendes Handbuch stellt sich der Aufgabe, über die Landwirtschaft im Departamento Cauca zu informieren, die engagierte Arbeit einer kleinbäuerlichen Vereinigung zu skizzieren, Prinzipien, Möglichkeiten und Hemmnisse des organischen Obstbaues in den Tropen zu diskutieren sowie Anbaumethoden und Vermarktungsstrategien ausgewählter Pflanzenarten zu erläutern.

Ausgewählt wurden Ananas, Papaya, Maracuja, Mango, Zitrus, Guave, Guanaba (*Annona muricata*), Frucht- und Kochbanane, Zuckerrohr, Kaffee, Brombeere, Lulo (*Solanum quitoense*) sowie Chontaduro (*Bactris gasipaes*). Nutzpflanzenbezogen sind wissenschaftliche Erkenntnisse und praktische Erfahrungen zu Botanik, Ökophysiologie, Fruchtfolge, Anzucht und Pflanzung, Düngung, Baumschnitt, Bewässerung, Regulierung von Beikräutern, Krankheiten und Schaderregern, Reifekriterien und Erntemethoden zusammengestellt worden.

Der Dreiklang Boden - Pflanze - Tier erfährt eine praktisch anwendbare Darstellung. In diese sind einbezogen, das System Boden und die unterschiedlichen Wechselwirkungen

zur Erhaltung der Bodenfruchtbarkeit, die Gründung sowie Beispiele zur Bodenbedeckung und Möglichkeiten einer integrierten Tierproduktion (Rinder, Schafe, Hühner, Meerschweinchen, Imkerei).

Nachertprozesse, Verarbeitung und Vermarktung werden an Beispielen im abschließenden Kapitel behandelt sowie interdisziplinär und fachübergreifend dargestellt.

Das Autorenverzeichnis umfasst 31 Mitarbeiter und dürfte eine wertvolle Basis für einen fachübergreifenden Meinungsaustausch bilden.

Im Anhang sind tabellarisch Inhaltsstoffe von tropischen Obstarten, Pflanzenarten mit nützlichen Wirkungen, in Praxis erprobte Applikationsmischungen gegen Schaderreger und Krankheiten sowie Empfehlungen der IFOAM zusammengestellt.

Hans Hemann, Witzenhausen

Alsing, Ingrid; 2002

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Hans Hemann, Witzenhausen

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Hans Hemann, Witzenhausen

Merrett, Steven; 2002

Water for Agriculture. - Irrigation Economics in Intentional Perspective.

235 pages, numerous tables, diagrams and figures, Spon Press, Taylor and Francis, London and New York, 2002; ISBN 0415-25239-3. - Price: £29.99

Considering well known projections which indicate a continuing growth of the world's population the constantly diminishing availability of water recourse is of increasing concern. Irrigated agriculture, being a prime consumer of water, will have to allocate this scarce factor much more efficiently in order to safeguard an adequate supply for drinking purposes. Under these auspices the discipline of irrigation economics is of utmost importance. This book covers a wide array of topics, comprising aspects of demand for irrigation services on the side of farm families and agribusinesses, as well as the supply, i.e. infrastructure and irrigation services and maintenance management. Case studies from different regions of the world facilitate understanding of interrelated problems. A large chapter is devoted to social cost-benefit analysis for irrigation and drainage projects. The text concludes by applying institutional economics methodology to irrigation policy and the design of respective policy instruments. The book is extremely useful and provides essential tools for planners of water recourse, and for professionals of agricultural development, recourse economics, water engineering and environmental sciences.

Eckhard Baum, Witzenhausen

Bender, Andrea; 2001

Fischer im Netz. Strategien der Ressourcennutzung und Konfliktbewältigung in Ha'apai, Tonga.

316 Seiten, 4 Abbildungen, 9 Karten; Sozialökonomische Prozesse in Asien und Afrika, Band 7, Centaurus Verlag, 79336 Herbolzheim, 2001, ISBN 3-8255-0328-3; Preis br: € 29,90

Unter den Bedingungen Tongas bildet der Fischfang neben dem Bodenbau die eine Säule der Subsistenzsicherung. Trotz zahlreicher Umwälzungen und Neuerungen ist das traditionelle Beziehungsgeflecht weitgehend erhalten geblieben. Fische zu fangen bedeutet nicht nur, mit proteinreicher Nahrung versorgt zu sein oder Geld zu verdienen. Der Fischfang stellt auch sicher, daß man seinen zahlreichen Verpflichtungen innerhalb des sozialen Netzes und der Kirche nachkommen kann. Nutzergruppen, die in hohem Maße mit ihrer Umwelt vertraut sind und auf die vorhandenen Ressourcen essentiell angewiesen sind, charakterisieren sich häufig durch effiziente, zentral in der Kultur verankerte und allgemein akzeptierte Institutionen, die kooperative und nachhaltige Strategien fördern. Veränderte Rahmenbedingungen, wie z.B. eine staatliche Gesetzgebung, die den Regeln zuwiderläuft, können diese Institutionen destabilisieren.

Zentraler Gegenstand der Arbeit ist der Einfluß kultureller Kontextfaktoren auf individuelle Strategien der Ressourcennutzung am Beispiel der Fischer zweier Inselgemeinden Tongas.

Zum Verständnis der Strategien und Möglichkeiten werden die ökologischen Grundlagen maritimer Ressourcen definiert und die traditionellen Fangtechniken sowie die Organisationsformen und die institutionellen Regulierungsmechanismen unter Berücksichtigung der jüngsten technologischen und kommerziellen Änderungen beschrieben.

Traditionelle Beschränkungen des Zugangs zu den maritimen Ressourcen wurden bereits vor Hundert Jahren durch Reformen sowie im Zuge der Christianisierung außer Kraft gesetzt. In Gruppenkonsens formulierte Regeln fehlen. Neue gesetzliche Einschränkungen existieren *de jure*, werden aber ignoriert. Charakterisiert durch den rechtlich gesicherten Zugang aller entsprechen die Bedingungen den Kriterien einer ökologisch-sozialen Konfliktsituation. Ausgestattet mit detailliertem Wissen und weiterentwickelten traditionellen Fangmethoden haben die Fischer alle Möglichkeiten zur Übernutzung der zwar erneuerbaren aber begrenzten Ressourcen. Im Zuge der Kommerzialisierung wird es möglich, Überschüsse zu vermarkten und mit den Erträgen das Ansehen zu steigern.

Generell verfolgen die Fischer das Ziel, in der Lage zu sein, ihre sozialen Pflichten zu erfüllen. Das beinhaltet drei Aspekte, nämlich ausreichend Fisch zu fangen: um (1) die Versorgung der eigenen Familie zu sichern, (2) anderen Familien und Personen, denen man Tribut pflichtet, einschließlich der Kirche, abzugeben und (3) einen Überschuß zu verkaufen, um den Geldbedarf zu decken. Die beiden untersuchten Gemeinden unterscheiden sich trotz gleicher kultureller Rahmenbedingungen in der Nutzungsintensität der Fisch-Ressourcen. Diese korrespondiert mit dem Kommerzialisierungsgrad, was sich in der Zahl der kommerziell Fischenden ausdrückt. Da diese in der Regel Außenseiter sind, folgert die Verfasserin, daß dort wo das soziale Netz noch weitgehend intakt ist,

die Kommerzialisierung vermindert und das Überfischen in Grenzen gehalten wird. Allerdings sieht auch die Verfasserin in dieser Erkenntnis nicht den Schlüssel für die Lösung des Problems, da allgemein noch die Vorstellung verbreitet ist, daß die Ressourcen nicht wirklich begrenzt sind. Auch das Problem der stetigen Zunahme der Nutzer durch das Bevölkerungswachstum, ein Aspekt, der in der Studie nur am Rande betrachtet wird, muß die Nachhaltigkeit beeinträchtigen. So endet die Verfasserin mit der These, daß Maßnahmen zur Beseitigung der strukturellen Hindernisse für nachhaltige Nutzung auf Dorfebene allein nicht ausreichen, sondern daß sie im allgemeineren wirtschaftlichen und sozialen Kontext angegangen werden müssen.

Insgesamt legt die Verfasserin eine Arbeit vor, die für Ethnologen, Umweltpsychologen und Wirtschaftswissenschaftler äußerst interessant ist, insbesondere, wenn sie in der Entwicklungszusammenarbeit tätig sind.

Eckhard Baum, Witzenhausen

Wolff, P., Hethke, M. und K. Hammer; 2002

100 Jahre Gewächshäuser für tropische Nutzpflanzen in Witzenhausen. Von der kolonialen Pflanzensammlung zur Forschungs- und Bildungseinrichtung.

64 Seiten. Beiheft Nr. 74 zu Der Tropenlandwirt. Verband der Tropenlandwirte Witzenhausen e.V., Universitätsbibliothek Kassel. ISBN: 3-89792-084-0. € 5.-

Die weit über den nordhessischen Raum hinaus bekannten Gewächshäuser für tropische Nutzpflanzen in Witzenhausen blickten im Jahr 2002 auf 100 Jahre ihrer Geschichte zurück: 1902 wurde die erste Gewächshausanlage als Lehr- und Forschungseinrichtung des tropischen Pflanzenbaues errichtet. Dies haben die Autoren der vorliegenden Schrift zum Anlass genommen die Geschichte dieser Lehr- und Forschungseinrichtung zu recherchieren und die Ergebnisse dieser Recherche als Festschrift des 100jährigen Geburtstages der Öffentlichkeit zugänglich zu machen.

Nach einer kurzgefassten Darlegung der generellen geschichtlichen Entwicklung von Gewächshäusern zu Hilfsmitteln der Lehre und Forschung zeigen die Autoren die Entwicklung der Witzenhäuser Einrichtung von einer kolonialen Pflanzensammlung zu einer Forschungs- und Bildungseinrichtung auf. Dabei wird auf die konzeptionelle, die bauliche Entwicklung sowie die der Pflanzensammlung eingegangenen. Betrieb und Bewirtschaftung der Gewächshauseinrichtung in Reaktion auf die sich wandelnden Herausforderungen stellen ein weiteres Kapitel dar. Dabei hatte das Gewächshausmanagement stets den Spagat zu leisten die Anforderungen einer wissenschaftlichen Pflanzensammlung zu erfüllen, die Einbindung der Einrichtung in die Lehre und Forschung der verschiedenen Ausbildungseinrichtungen mit den Anforderungen der Umweltbildung für externe Zielgruppen und die der Öffentlichkeitsarbeit zu gewährleisten. Dass dies bisher gelungen ist machen die Autoren an der Wertschätzung und Anerkennung deutlich, der sich die Einrichtung in Fachkreisen und in der Öffentlichkeit erfreut. Sie machen aber auch deutlich,

dass die Einrichtung ihre vielfältigen Aufgaben künftig nur erfüllen kann, wenn sie sich den ständig wechselnden Herausforderungen stellt, und wenn sie die erforderliche Unterstützung der Trägerinstitution und der unterschiedlichen Förderinstitutionen erfährt.

Hans Hemann, Witzenhausen

Meyer-Renschhausen, E., Müller, R. und P. Becker (Hrsg.); 2002

Die Gärten der Frauen: Zur sozialen Bedeutung von Kleinstlandwirtschaft in Stadt und Land weltweit. Internationale Konferenz: Perspektiven der Kleinstlandwirtschaft und Gärten in Stadt und Land. Zur sozialen und ökologischen Notwendigkeit einer „Weiblichen Ökonomie“

336 Seiten, ISBN 3-8255-0338-0, Centaurus-Verlag, Herbolzheim € 22,40 .

Gärten sind ein Phänomen. Steigt der Wohlstand, werden sie zu einem Element seiner Dekoration. Werden die Zeiten schlechter, dienen sie mehr der Nahrungsmittelproduktion und schließlich dem Überleben. Aber es gibt noch andere Gesetzmäßigkeiten , für die man jetzt vorsichtig Forschungsprojekte formuliert und Ansätze erarbeitet.

Das vorliegende Buch ist ein gutes Beispiel für die neuen, längst fälligen und daher höchst willkommenen Entwicklungen. Die Frauen werden in den Vordergrund gestellt, sicherlich taktisch wirkungsvoll, wenn auch in vielen Gärten Männer die führende Rolle übernehmen oder die ausschließliche Zuständigkeit haben.

Insgesamt werden im Buch die verschiedenen Formen der Kleinstlandwirtschaft behandelt, und auf ihre soziale, ökonomische und ökologische Notwendigkeit wird eingegangen. Fünf große Abschnitte werden behandelt. „Weibliche Ökonomie“ wird charakterisiert mit Beispielen aus verschiedenen Teilen der Welt (dörflich - bäuerliche Kultur der Warburger Börde bis städtische Landwirtschaft in Bolivien). In diesen Abschnitt gehören auch grundsätzliche Arbeiten zur „Weiblichen Ökonomie“ von E. Meyer - Renschhausen und H. Inhetveen.

Ein zweiter Abschnitt behandelt das „Überleben“, durch Kleinstlandwirtschaft besonders in den Städten Afrikas, aber auch auf dem Lande Osteuropas. Um „anders Leben“ dreht sich ein weiterer Abschnitt. Markante Beispiele behandeln das „Community Gardening“ in New York oder die „Selbstversorgungsguerilla“ in Japan. „Lebenskeime“ werden in einem weiteren Abschnitt aufgespürt (u.a. Immigrantengärten in Bonn und traditionelle Saatkunst in Südtirol).

Schließlich wird „das gute Leben“ untersucht mit Beispielen aus Nordamerika und Osttirol, wobei auch die „heilende Kraft der Gärten“ nicht vergessen wird.

Außer den in den Beiträgen überwiegend behandelten sozialen Aspekten, gibt es natürlich noch eine Vielzahl weiterer Elemente, die in der wissenschaftlichen Durchdringung eine Rolle spielen. So können die Gärten auch Erhaltungs- und Evolutionszentren für pflanzen genetische Ressourcen sein. Weitere Themenfelder ließen sich anschließen, so daß es Zeit ist, die Kleinstlandwirtschaft aus ihrem wissenschaftlichen Mauerblümchendasein herauszuholen. Das vorliegende Buch ist ein guter Schritt in dieser Richtung.

Karl Hammer, Witzenhausen

Heisteringer, A.; 2001

Die Saat der Bäuerinnen. Saatkunst und Kulturpflanzen in Südtirol.

Innsbruck - Bozen (edition löwenzahn in der Studien Verlag GmbH), 149 S.+ 16 Farbtafeln, ISBN 3 - 7066 - 2253 - X, Preis: € 20

Das Buch ist das beachtliche Ergebnis einer Diplomarbeit. Zum Einsatz kam die qualitative Sozialforschung, als Werkzeuge dienten die teilnehmende Beobachtung und das narrative Interview. Ein kleines Gebiet von Südtirol wurde auf seine Hausgärten untersucht, die dort ausschließlich von Frauen bewirtschaftet werden.

Das Material wird gründlich untersucht. Das zeigt sich auch an den Kulturpflanzen. So gelingt der Anbau-Nachweis einer Lupine, deren Samen als Kaffeeersatz dienen („Althreiner Kaffee“, *Lupinus cosentinii*), der uns in eigenen größer angelegten Untersuchungen in Italien bisher nicht gelungen war. Buchweizen, Brotklee, Faserlein und andere kulturpflanzenfloristische Raritäten werden nachgewiesen. Aber es zeigte sich auch das Bild eines in den letzten Zügen liegenden gartenmäßigen Anbaus.

Die wichtigsten Informantinnen hatten die Lebensmitte schon längst überschritten. Man muß also nicht auf „Mythos und Brauch“ zurückgreifen. Es gibt noch die unmittelbare kulturelle Erinnerung. Aber man steht vor ähnlichen Problemen wie bei den Kulturpflanzen selbst, von denen nur noch letzte Relikte zu finden sind, in denen die biologische Evolution „eingraviert bleibt“.

Reichen also die gefundenen Indizien aus, um ein abgerundetes Bild zu liefern? Sicherlich nicht! Aber sie erlauben gewisse Hinweise auf die traditionellen Methoden der Selektion durch die Bäuerinnen und Bauern, reichlich gewürzt mit durchaus aufschlußreichen Meinungen der Befragten. Eine umfangreichere Literaturumschau hätte hier klärend und objektivierend wirken können und wäre wahrscheinlich gleichzeitig zu umfassend für eine Diplomarbeit geworden.

So wird eine pauschal abqualifizierte „professionelle Pflanzenzüchtung“ (ihre Kritikwürdigkeit soll nicht in Zweifel gestellt werden), die „Pflanzenzüchtung der Konzerne“, ohne ihre eingehende soziologische oder andere Untersuchung mit der „Saatkunst der Bäuerinnen“ in einem kleinen Gebiet Südtirols vergleichen, die nur noch als Relikt vorliegt.

Vielleicht liegt die größte Leistung des Buches in seinem Beitrag zur Erhaltung der Kulturpflanzenvielfalt durch gute kulturelle und biologische Untersuchungen in Südtirol. Nach einem alten Grundsatz der Biodiversität kann man nur das schützen was man kennt. Dieser Schritt ist getan. Wie die weiteren Schritte in einer heute schon stark überalterten Randgruppe aussehen können, bleibt offen. Wird die „Saatkunst der Bäuerinnen“ in Südtirol eine Zukunft haben ?

Karl Hammer, Witzenhausen

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