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Hans Hemann, Steinstraße 19, D 37213 Witzenhausen, Tel. 05542 - 981216,  
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## Evaluierung des Modells für integrierte Schädlingsbekämpfung im Baumwollanbau durch Kontaktbauern in der Harran Ebene<sup>1</sup>

Y. Aktas <sup>2</sup>

### Übersicht

In dieser Untersuchung wird eine Evaluierung des Beratungsprojektes „Integrierte Schädlingsbekämpfung im Baumwollanbau durch Kontaktlandwirte“ des Pflanzenschutzamtes der Provinzstadt Sanliurfa aus dem Jahr 1999 beschrieben. Mit einem einfachen Evaluierungsansatz werden die Ziele und die Arbeitsmethoden der Beratungsorganisation untersucht. Dazu wurde eine Befragung mit 54 Landwirten in 18 Dörfern und mit 12 Beratern durchgeführt. Die Mehrheit der Berater hat langjährige Berufserfahrung, insbesondere auch in der Provinz und schätzen ihre Klienten im Pflanzenschutz als beratungsbedürftig ein. Jedoch ist der Wissensstand der Berater in Bereichen außerhalb der Produktionstechnik noch gering. Die Wirksamkeit des Beratungsansatzes zeigt sich vor allem dadurch, dass der Wissensstand der Kontaktlandwirte in produktionstechnischen Fragen fast durchgängig wesentlich höher angetroffen wird, als derjenige der Kontrolllandwirte. Auch liegt die Übernahmequote bei den vom Pflanzenschutzdienst empfohlenen Neuerungen bei den Kontaktlandwirten wesentlich höher als bei den Kontrolllandwirten.

Die Wirksamkeit des Pilotprojektes ließe sich durch verschiedene Maßnahmen noch nachhaltig verbessern, dazu werden entsprechende Empfehlungen gegeben. Einschließlich dieser Verbesserungen erscheint der Beratungsansatz auch für andere Bewässerungsgebiete in der Türkei als geeignet.

**Stichwörter:** Evaluierung, integrierte Schädlingsbekämpfung, Kontaktbauern, Baumwolle, Türkei, Harran Ebene

### 1 Einleitung

Die aktuelle Politik in der Türkei ist durch zunehmende Globalisierung und die Vorbereitung zum Beitritt in die Europäische Union bestimmt. Um sich zunehmend in die Europäische Union zu integrieren, muss die Türkei nicht nur die Wettbewerbsfähigkeit ihres industriellen Sektors und ihres Außenhandels verbessern, sondern auch die Wettbewerbsfähigkeit ihrer Landwirtschaft fördern. In diesem Zusammenhang kommt der landwirtschaftlichen Beratung eine wichtige Rolle zu. Forschung und Beratung müssen

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<sup>1</sup> Mein Dank gilt Herrn Prof. Dr. Volker Hoffmann für seine kritischen Anmerkungen und sprachliche Korrekturvorschläge. Für die hier geäußerten Meinungen bin ich jedoch allein verantwortlich.

<sup>2</sup> Yasar Aktas, Abteilung Agrarökonomie der Fakultät für Agrarwissenschaften an der Universität Harran, Eyyübiye Kampüsü, Sanliurfa-Türkei. E-Mail: yaktas@harran.edu.tr

dem Agrarbereich Problemlösungs-Strategien liefern, die es möglich machen, die vorhandenen physischen und menschlichen Ressourcen effektiv zu nutzen.

In einer ersten Sondierung wurden alle staatlichen landwirtschaftlichen Organisationen in der Provinz Sanliurfa interviewt, um herauszufinden, welche Probleme sie benennen und ob sie Interesse daran haben, dass eine empirische Untersuchung zu einem ihrer Problembereiche durchgeführt wird. Eigeninteresse erschien entscheidend, da der Erfolg einer Evaluierung von der Unterstützung der betroffenen Institution abhängt (ALBRECHT, 1972). Der Pflanzenschutzdienst des Landwirtschaftsamts der Provinz Sanliurfa zeigte ein überdurchschnittliches Interesse, da er ein Projekt in der Harran Ebene durchführt, das „integrierte Schädlingsbekämpfung im Baumwollanbau durch Kontaktbauern“ genannt wird. Die Harran Ebene liegt in der südöstlichen Türkei und reicht bis an die türkisch-syrische Grenze. Innerhalb der Provinz Sanliurfa erstreckt sie sich über 250 000 ha. Seit 1995 wird die Harran Ebene in zunehmendem Umfang bewässert, und im Jahre 2000 betrug die bewässerte Fläche schon über 118 000 ha. Die zentrale Kultur im Bewässerungsgebiet ist Baumwolle, mit mehr als 85% Flächenanteil.

## 2 Die Zielsetzung

Diese Untersuchung verfolgt folgende Ziele:

- (1) Das Modell des Pflanzenschutzdienstes zur integrierten Schädlingsbekämpfung durch Kontaktbauern zu analysieren,
- (2) Den Einfluss der Kontaktlandwirte auf die Übernahme von empfohlenen Neuerungen im Baumwollanbau durch den Pflanzenschutzdienst zu ermitteln.

Als Faktoren, die die Organisation der Beratungsarbeit, die Arbeitsweise sowie die Verbreitung der empfohlenen Neuerungen beeinflussen, werden berücksichtigt:

- (a) Faktoren, die der Pflanzenschutzdienst direkt beeinflussen kann:
  - angewandtes Modell und das beratungsmethodische Vorgehen
  - persönliche und berufsbezogene Merkmale der Berater und
  - die Aus- und Fortbildung der Berater.
- (b) Faktoren, auf die der Pflanzenschutzdienst keinen direkten Einfluss haben:
  - persönliche und soziale Merkmale der befragten Landwirte,
  - das vorliegende produktionstechnische Wissen und die Erfahrungen der Landwirte,
  - die Koordination und Kooperation mit weiteren Institutionen, die die Beratungsarbeit beeinflussen können.

## 3 Methodik der Evaluierung

Der Begriff Evaluierung wird von verschiedenen Autoren (FRUTCHEY, 1959; ALBRECHT, 1972, 1990; FOREST *et al.*, 1994; VAN DEN BAN und HAWKINS, 1996) für teilweise unterschiedliche Zielsetzungen verwendet. In dieser Arbeit gehe ich von folgender Definition aus: „Evaluierung als wissenschaftliche Analyse zur Feststellung der wirksamen Faktoren und Eruierung von Ursache-Wirkungs-Beziehungen.“ (HRUSCHKA, 1972). ALBRECHT

(1972) erläutert dies noch näher: „Eine einfache Evaluierung muss dann zumindest ermitteln, wie viel nach der Durchführung eines Programms erreicht worden ist.“ In der durchgeführten Evaluierung wurden zwei Schritte, nämlich eine Situationsanalyse und die Ermittlung der eingesetzten Beratungsmethode hintereinander geschaltet, die nachstehend noch näher beschrieben werden.

### **3.1 Die Situationsanalyse**

Hierzu wurden die folgenden Fragen aufgestellt und untersucht:

- persönliche und soziale Merkmale der befragten Landwirte,
- das vorliegende produktionstechnische Wissen und die Erfahrungen der Landwirte,
- Hat der Pflanzenschutzdienst die bestehenden Probleme zutreffend erfasst und gekennzeichnet?
- Welches Problem wird von den Befragten als das wichtigste angesehen?
- Welches sind die Zielsetzungen des Pflanzenschutzdienstes? Sind sie zutreffend formuliert?
- Welche Methoden werden eingesetzt, um diese Ziele zu erreichen?
- Wurde eine Evaluierung vorgesehen?
- Hat man die Zielgruppe angemessen bestimmt und ausgewählt?
- Welche Probleme haben die Berater? Wie schätzen die Berater ihre Klienten ein? Wie sind ihre Beziehungen zu den Kontaktlandwirten?
- Hat man die zur Verfügung stehende Beratungskapazität voll ausgenutzt?
- Kooperiert der Pflanzenschutzdienst mit staatlichen und privaten Institutionen, die das Innovationsverhalten der Zielgruppe beeinflussen?
- Wie ist der Wissensstand der Zielgruppe zur Produktionstechnik im Baumwollanbau?
- Wie verhält sich die Zielgruppe gegenüber den durch den Pflanzenschutzdienst empfohlenen Neuerungen?
- Welche Informationsquellen nutzt die Zielgruppe, welche nicht und warum?

### **3.2 Die Beratungsmethode des Pflanzenschutzdienstes**

Die Bestimmung der Beziehung zwischen den Beratern und der Zielgruppe ist entscheidend für die Qualität der Beratungsarbeit. Daher werden zur Arbeitsmethode des Pflanzenschutzdienstes die folgenden Fragen gestellt und untersucht:

- Wie sieht die für die Aufgabe entwickelte Methode aus?
- Wie wurden die Berater für die Beratungsarbeit vorbereitet?
- Hat man die Verhaltensmöglichkeiten und die Optionen der Verhaltensänderung der Zielgruppe zutreffend analysiert und das Vorgehen darauf abgestimmt?
- Welche Erfahrungen hat man im konkreten Projektgebiet gesammelt?
- Welche Erfahrungswerte sind auch auf andere Regionen übertragbar?

Im Rahmen dieser Arbeit konnte das Aufwands-Ertrag-Verhältnis nicht näher untersucht werden, da es dazu, nach der eigenen Aussage des Pflanzenschutzdienstes, keine genaueren Daten gab.

### **3.3 Untersuchungsmethode**

Die Studie stützt sich auf vorhandene schriftliche Informationen des Pflanzenschutzdienstes und auf die Ergebnisse der im Jahre 2000 im Projektgebiet durchgeführten Erhebungen. Zunächst wurde die Beratungsarbeit der Berater mit den Kontaktbauern in 10 verschiedenen Dörfern beobachtet. Auf der Grundlage der durch diese Beobachtungen gewonnenen Informationen und der Untersuchungsziele wurde sodann ein standardisierter Fragebogen entworfen. Er wurde anschließend in ausgewählten Dörfern getestet. Nach einer Überarbeitung wurde dann mit der Hauptuntersuchung begonnen.

Der Pflanzenschutzdienst hat im Jahre 1999 in 36 Dörfern der Harran Ebene, denen Bewässerungsanlagen zur Verfügung stehen, mit dem Modellprojekt „Integrierte Schädlingsbekämpfung im Baumwollanbau durch Kontaktbauern“ begonnen. Für die Untersuchung wurde die Hälfte der betroffenen Dörfer ausgewählt. Bei der Auswahl dieser 18 Dörfer spielten die Merkmale Entfernung zwischen den Dörfern und Entfernung zur Stadt eine entscheidende Rolle. Der Pflanzenschutzdienst arbeitete nur mit einem Kontaktlandwirt pro Dorf. Zusätzlich zu diesem wurden in jedem Dorf als Kontrollgruppe auch zwei weitere Baumwollanbauer ausgewählt, unter Zuhilfenahme einer Namensliste, die von der örtlichen Bewässerungsorganisation bereitgestellt wurde. Von den Landwirten mit vergleichbarer Betriebsgröße zum Kontaktbauern wurden nach dem Zufallsprinzip zwei ausgewählt. Dieses Verhältnis von 1/3 Kontaktbauern zu 2/3 Kontrollgruppen-Landwirten wird bei der Interpretation der Ergebnisse wichtig. Insgesamt wurden 54 Landwirte befragt.

Innerhalb des Modellprojekts waren insgesamt 20 Berater beschäftigt. Nur 12 Berater konnten interviewt werden, da diese die Beratungsarbeit durchführten. Die übrigen 8 Beratern wurden im Untersuchungsjahr in andere Provinzen versetzt und konnten daher nicht befragt werden. Alle Interviews sind vom Verfasser persönlich durchgeführt worden.

## **4 Das Modellprojekt für integrierte Schädlingsbekämpfung im Baumwollanbau durch Kontaktbauern**

Die Gründe für die Entstehung dieses Modellprojekts lassen sich unter zwei Punkten zusammenfassen. Einerseits erstellte das türkische Ministerium für Landwirtschaft und Dorfangelegenheiten ein Rahmenmodell für den integrierten Pflanzenschutz. Seit der Inbetriebnahme der Bewässerungsanlagen machte der Pflanzenschutzdienst zunehmend die Erfahrung, dass die Anwendung von Pflanzenschutzmitteln in der Harran Ebene ständig zunahm und letztlich außer Kontrolle geriet. Dafür waren vier Ursachen verantwortlich (vgl. RASTGELDI (2000)):

- Die enorm großen Flächen des Betreuungsgebiets,
- Die enorm große Zahl der zu beratenden Landwirte,
- Die unzureichende Zahl an qualifizierten Beratern, und

- ihre nur geringe technische Ausstattung.

Unter diesen Gegebenheiten entwickelte der Pflanzenschutzdienst ein an die örtlichen Bedingungen angepasstes Modell, dessen wichtige Eigenschaften im Folgenden dargestellt werden.

#### **4.1 Integrierter Pflanzenschutz und Funktionen**

Integrierter Pflanzenschutz wird als ein Verfahren definiert (HOFFMANN *et al.*, 1985), „bei dem alle biologischen, kulturellen und toxikologisch vertretbaren Methoden verwendet werden, um Schädlinge unter der Schadensschwelle zu halten“. Es geht darum, „...Änderungen natürlicher Prozesse mit einem Minimum an Aufwand vorzunehmen und dabei nach Möglichkeiten eine Kombination von miteinander verträglichen Maßnahmen statt eines einzelnen durchschlagenden Verfahrens anzuwenden.“

Mit diesem Modell sollen die folgenden zwei Ziele erreicht werden (vgl. RASTGELDI (2000)),

- dass die Landwirte sich überwiegend selbst beraten
- und dass der Pflanzenschutzdienst die vorhandenen Beratungskräfte und die technische Ausrüstung effektiv nutzen kann.

Die Funktionen des integrierten Pflanzenschutzes fasst RASTGELDI (2000) unter drei Punkten zusammen:

- Die Beratung der Klienten über geeignete Pflanzenschutzmethoden,
- eine effektive Zusammenarbeit und die Schaffung einer vertrauensvollen Atmosphäre zwischen dem Berater und dem Kontaktlandwirt,
- die Unterstützung der Klienten bei der Übernahme der Funktion eines Kontaktlandwirts im Dorf, den die übrigen Landwirte als ein Vorbild und Beispiel bei der Anwendung von Pflanzenschutzmethoden ansehen.

#### **4.2 Auswahl der Projekt-Dörfer**

Die Wahl der Harran Ebene als großflächiges Bewässerungsgebiet mit intensivem Baumwollanbau war der Auslöser für das Projekt und hinreichender Zugang zur Bewässerung war insofern auch ein wichtiges Auswahlkriterium für die Projektdörfer. Das Arbeitsgebiet wurde geographisch in vier Teile eingeteilt. Bei der Auswahl der Dörfer in jedem geografischen Viertel wurde darauf geachtet, dass die Dörfer auf guten Strassen leicht erreichbar waren, weil die Berater täglich von der Provinzstadt Sanliurfa aus dorthin fahren mussten. Für jedes geographische Viertel wurde ein Beraterteam gebildet, das aus fünf Beratern bestand und das die Kontaktbauern sowohl auswählte als auch über die gesamte Vegetationsperiode hinweg zu beraten hatte.

Der einzelne Berater konnte mitentscheiden, in welchem Team er arbeiten wollte. Damit war eine günstige Ausgangslage für eine harmonische Zusammenarbeit unter den Beratern gegeben. Zu jedem Beraterteam gehörte mindestens ein im Baumwollanbau länger erfahrener Berater. Die Teams waren nicht hierarchisch strukturiert, alle Berater im Team waren gleichgestellt. Jedes Beraterteam hatte einen Pkw zur Verfügung.



### **4.3 Die Auswahl der Kontaktbauern und deren Funktionen**

Die Auswahl der Kontaktbauern erfolgte nach den folgenden drei Kriterien:

- Der Kontaktbauer soll ausreichend mit technischen Geräten und Maschinen ausgestattet sein
- Er sollte eine positive Einstellung zur Beratungsarbeit haben.
- Sein Baumwollfeld sollte von den anderen Landwirten gut erreichbar und beobachtbar sein.
- Die Baumwollfelder in jedem Dorf sollten so als eine Art Demonstrationsfeld betrachtet werden und wirken. Die Betriebsgröße hat bei der Auswahl der Kontaktbauern keine Rolle gespielt, da man nur bis 10 ha Baumwollanbaufläche pro Betrieb die integrierten Pflanzenschutzmassnahmen betreut hat. Falls der Kontaktbauer mehr als 10 ha Baumwolle hatte, musste er auf der darüber hinausgehenden Fläche die Maßnahmen selbst durchführen.

In jedem ausgewählten Dorf arbeitete man nur mit einem Kontaktbauern und jeweils nur ein Jahr lang. Danach wechselt der Pflanzenschutzdienst in ein anderes Dorf und betreute einen neuen Kontaktbauern in der Annahme, dass Kontaktbauern nach einem Jahr in der Lage seien, die neuen Pflanzenschutzmethoden in ihren Baumwollfeldern selbst anzuwenden und auch die übrigen Landwirte im Dorf in Pflanzenschutzfragen zu beraten. Der Kontaktbauer sollte also zum Zentrum der Diffusion der Innovationen im Dorf werden (vgl. RASTGELDI (2000)).

### **4.4 Aktivitäten und Arbeitsweise der Beratung**

In der Regel besuchte jedes Beraterteam an vier Tagen pro Woche Kontaktlandwirte in verschiedenen Dörfern. Am fünften Tag wurden die im Pflanzenschutz vorgefundenen Probleme in der Provinzhauptstadt diskutiert und ausgewertet. An einem Arbeitstag besucht ein Beraterteam durchschnittlich 4 Kontaktbauern auf deren Hof bzw. auf ihren Feldern. Der Berater spricht alle akuten Fragen des integrierten Pflanzenschutzes mit dem Kontaktbauern durch und gibt entsprechende Empfehlungen. In der folgenden Woche werden die empfohlenen Maßnahmen kontrolliert und beurteilt. Falls das Beraterteam den Kontaktbauern einmal nicht antrifft, wird sein Baumwollfeld trotzdem aufgesucht und auf Krankheiten und Schädlinge hin kontrolliert.

Für jeden Kontaktbauern wurde ein Formular angelegt und darin wurden die Ergebnisse der Gespräche und der Aktivitäten mit den Kontaktbauern festgehalten, aber auch ein Kurzprotokoll über das wöchentliche Auswertungstreffen erstellt.

Die Aktivitäten des Pflanzenschutzdienstes begrenzten sich hauptsächlich auf Baumwolle und Weizen. Die Berater sind vorrangig auf Fragen des Pflanzenschutzes spezialisiert. Darüber hinaus beraten sie die Landwirte aber auch in Fragen der sonstigen Produktionstechnik, wie z.B. Saatgut, Feldbestellung, Bewässerung und Düngung.

## **5 Ergebnisse der Untersuchung**

Die Untersuchungsergebnisse werden nach zwei Aspekten gegliedert dargestellt. Einerseits nach dem Beratersystem und andererseits nach dem Klientensystem.

## 5.1 Beratersystem

Zunächst werden die persönlichen und beruflichen Merkmale der Berater vorgestellt. Die Mehrheit (92 %) der befragten Berater ist älter als 35 Jahre und 83 % haben Berufserfahrung von mehr als 11 Jahren (vgl. Tab. 1). 50 % der Berater sind seit mehr als 11 Jahren in Sanliurfa beschäftigt. Die älteren Berater haben bei den Klienten in dieser Region ein besonderes Ansehen, da das Alter besonders geachtet wird. Die überwiegende Mehrheit (92 %) der befragten Berater hat nur an einem Fortbildungskurs teilgenommen. Während 58 % diese Kurse positiv beurteilen, schätzen 33 % diese für schlecht organisiert ein. Nach dem Grund gefragt, antworteten die Berater, dass diese Kurse sehr theoretisch und nicht ausreichend praxisorientiert seien. Nur ein Berater nahm an keinerlei Fortbildungskursen teil.

Auf die Frage „Ob der Pflanzenschutzdienst die Berater auf die Arbeit im Modellprojekt genügend vorbereitet hat“ erwiderten 58 % mit Ja und 42 % mit Nein. Der Kern derer, die verneinen, besteht aus jüngeren und weniger erfahrenen Beratern. Daraus kann man ableiten, dass die Berater auf neu anstehende Aufgaben systematisch vorbereitet werden sollten. Die Berater wurden auch gefragt, ob sie sich für diese Beratungsarbeit für kompetent halten. 83 % antworteten mit ja und 16 % mit nein. Auch hier sind es ausschließlich jüngere Berater mit geringerer Berufserfahrung, die nicht am Fortbildungskurs teilgenommen haben, die nein sagen.

Die Berater wurden zu ihrer Einschätzung der Landwirte in der Harran Ebene befragt. 42 % beurteilen die Landwirte gegenüber Innovationen als aufgeschlossen, fügen aber hinzu, dass sie wenig Wissen und Erfahrung in Bewässerungslandwirtschaft haben.

42 % meinen, dass die Landwirte auch Probleme bei der Übernahme von Neuerungen hätten. Ein Berater ist sogar der Meinung, dass die Landwirte gar keine Kenntnisse in Bewässerungslandwirtschaft hätten. Ein weiterer Berater will sich zu dieser Frage nicht festlegen. Daraus kann man zumindest schließen, dass die Berater ihre Klienten für beratungsbedürftig ansehen. Auf die Frage, ob man Konsequenzen aus dieser Beratungsarbeit gezogen habe, antworten 75 % mit Ja, der Rest mit Nein. Weitergehende Fragen ergaben, dass die einzelnen Berater für sich persönlich Konsequenzen aus ihrer Beratungsarbeit mit Kontaktlandwirten gezogen haben.

Schließlich wurden die Berater nach dem wichtigsten Problem in ihrer eigenen Arbeit befragt. Für 25 % ist dies das Fehlen von technischen Beratungshilfsmitteln. 33 % nennen das niedrige Gehalt als ihr wichtigstes Problem, während 42 % die schlechte Organisation benennen.

Über Medieneinsatz könnte Beratungsarbeit effektiver gestaltet werden. Im persönlichen Gespräch bestätigte der Leiter des Pflanzenschutzdienstes, dass man keine technischen Hilfsmittel einsetzen könne, da diese nicht zur Verfügung stehen. Folgerichtig habe man auch keine Medien-Spezialisten im Dienst. Es wurden ausschließlich Drucksachen hergestellt und verteilt. Zusätzlich zu dem als gering eingeschätzten Gehalt wurden den Beratern auch keine Fahrtspesen bezahlt. Weiterhin wenig motivierend wirkte sich aus, dass die befragten Berater die Organisation der Beratungsarbeit im Feld und im Büro gleichermaßen als schlecht beurteilten.

**Tabelle 1:** Persönliche Merkmale und Einschätzungen bezüglich der Tätigkeiten der Berater

<i>Fragen</i>	<i>Antwortkategorien</i>	<i>Insgesamt abs. v.H.</i>
I. Lebensalter	a) 20-29	1 8,33
	b) 35-40	1 8,33
	c) 36-40	3 25,0
	d) 41 und mehr	7 58,33
II. Berufserfahrung in Jahren	a) 1-5	2 16,67
	b) 11-15	1 8,33
	c) 16 und mehr	9 75,0
III. Beschäftigungsdauer in Sanliurfa	a) 1-5	6 50,0
	b) 11-15	2 16,67
	c) 16 und mehr	4 33,33
IV. Teilnahme an Fortbildungskursen	a) Teilgenommen	11 91,67
	b) Nicht teilgenommen	1 8,33
V. Einschätzung der Fortbildungskurse	a) Gut	7 58,33
	b) Schlecht	4 33,33
	c) Nicht teilgenommen	1 8,33
VI. Vorbereitung	a) Ja	7 58,33
	b) Nein	5 41,67
VII. Selbsteinschätzung	a) Kompetent	10 83,33
	b) Nicht kompetent	2 16,67
VIII. Einschätzung der Landwirte durch die Berater	a) Aufgeschlossen, jedoch kaum Kenntnisse	5 41,67
	b) Probleme bei Übernahme von Neuerungen	5 41,67
	c) Kein Wissen über Bewässerungslandwirtschaft	1 8,33
	d) Keine Antwort	1 8,33
IX. Konsequenzen aus dieser Beratungsarbeit	a) Ja	9 75,0
	b) Nein	3 25,0

## 5.2 Klientensystem

Die Antworten von befragten Landwirten lassen sich nach 2 Punkten untergliedern: einerseits der Kenntnisstand der Landwirte zu den eingesetzten Techniken und andererseits ihr Übernahmeverhalten bei den Empfehlungen des Pflanzenschutzdienstes.

### 5.2.1 Der Kenntnisstand der Landwirte zu den eingesetzten Techniken

Zu den Beratungsinhalten wurden die folgenden zwei Fragen gestellt:

- (a) „Wissen Sie, dass manche Insekten, die im Baumwollanbau auftreten, Nützlinge sind?“ Wie in Tabelle 2 zu ersehen, bejahten dies 20 %, 31 % sagten jedoch nein. Der überwiegende Teil, nämlich 48 % gab an, darüber schon einmal etwas vom Berater gehört zu haben. An nähere Einzelheiten konnten sich diese Befragten dann allerdings nicht mehr erinnern. Die Zahl der Kontaktbauern (5), die Kenntnisse über Nützlinge hatten, war relativ gesehen, doppelt so groß, wie die der Kontrolllandwirte (6). Dieser Unterschied wird zwischen den Kontaktbauern und den Kontrolllandwirten bei der Kategorie „keine Kenntnis“ besonders deutlich.
- (b) Zu den Kenntnissen über den Düngungsaufwand wurde die folgende Frage gestellt: „Man sagt, wenn man erheblich stärker düngt, so begünstigt man das Auftreten von Schädlingen. Was halten Sie persönlich davon?“ 28 % gaben an, dass dies richtig sei. Der Kenntnisstand der Kontaktbauern zu dieser Frage ist erheblich höher als der der Kontrolllandwirte. Dagegen meinen 26 %, dass man weder zu viel noch zu wenig düngen sollte. Die Kontrolllandwirte sagen dies wesentlich häufiger als die Kontaktlandwirte. Man kann vermuten, dass die Befragten sich hier nach der im Untersuchungsgebiet weit verbreiteten Annahme richten: „Ein mittleres Maß kann nicht falsch sein“. Während 24 % der Meinung waren, dass man umso höhere Erträge erzielt, je mehr man düngt, gaben 22 % an, dass sie darüber keine genauen Kenntnisse haben. Bemerkenswert ist, dass kein Befragter darauf hingewiesen hat, dass man den Düngereinsatz am Ergebnis einer Bodenuntersuchung orientieren sollte.

Insgesamt kann man aus den vorgestellten Antworten ableiten, dass die Kontaktbauern durch die Betreuung der Berater genauere Kenntnisse erlangt haben, oder aber, dass man vorwiegend solche Landwirte ausgewählt hat, die schon über bessere Kenntnisse verfügen, als die übrigen Landwirte im Dorf. Aber auch, wenn die zweite Annahme zuträfe, wäre dies ein Erfolg für den Pflanzenschutzdienst und eine günstige Voraussetzung für die weitere Verbreitung der neuen Maßnahmen.

Vergleicht man die beiden Fragen, so sind die Kenntnisse der Befragten bei der Düngung besser als bei den Nützlingen. Dies lässt sich vermutlich von daher klären, dass es bei Düngung um eine praktische und eigene Tätigkeit geht, dagegen sind „Kenntnisse über Nützlinge“ eher ein allgemeines Wissen über Umweltbedingungen, dessen Anwendung dann spezifische Beobachtungen der Geschehnisse auf dem Baumwollfeld erfordert.

### 5.2.2 Übernahmeverhalten der befragten Landwirte bei den Empfehlungen des Pflanzenschutzdienstes

Der Pflanzenschutzdienst empfiehlt eine Feldbestellungszeit kurz nach der Baumwollernte. Um die Übernahme dieser Empfehlung zu überprüfen, wurde die folgende Frage gestellt: „In welchem Monat bestellen Sie Ihr Baumwollfeld?“ Tabelle 3 zeigt, dass 87 % der Befragten ihr Feld kurz nach der Baumwollernte, die in der Regel bis November dauert, bestellten. Dies entspricht der Empfehlung des Pflanzenschutzdienstes. Vergleicht

**Tabelle 2:** Kenntnisse der befragten Landwirte, unterschieden nach Kontaktbauern und Kontrolllandwirten

Art der Neuerungen	Antwortkategorien	Anzahl der befragten Landwirte					
		Insgesamt		Kontaktbauern		Kontrolllandwirte	
		abs.	v.H.	abs.	v.H.	abs.	v.H.
I. Kenntnisse über Nützlinge	a) hat Kenntnis	11	20,37	5	9,26	6	11,11
	b) von Berater gehört	26	48,15	11	20,37	15	27,78
	c) kein Kenntnis	17	31,48	2	3,70	15	27,78
II. Kenntnis über Düngeraufwand	a) Ja, richtig	15	27,78	13	24,07	2	3,70
	b) mittelmäßig	14	25,93	3	5,56	11	20,37
	c) kein Kenntnis	12	22,22	1	1,85	11	20,37
	d) je mehr Dünger, umso mehr Ertrag	13	24,07	1	1,85	12	22,22

man Kontaktbauern mit den Kontrolllandwirte, so sind die Kontaktbauern noch ein wenig häufiger auf der Linie der Empfehlung.

Der Pflanzenschutzdienst empfiehlt, sich bei der chemischen Behandlung des Saatguts auf drei verschiedene Schädlingsbekämpfungsmittel zu beschränken. Dieser Empfehlung folgen 22 % der befragten Landwirte. Dabei sind die Kontaktlandwirte relativ doppelt so häufig bei denen, die der Empfehlung folgen, als die Kontrolllandwirte. Aber auch hier lässt sich nicht zweifelsfrei nachweisen, dass dies ein Effekt der Beratungsarbeit des Pflanzenschutzdienstes ist, sie könnten es auch schon vorher gewusst haben oder aus anderen Informationsquellen entnommen haben.

Auf die Frage, „Von wem haben Sie erfahren, dass Sie so viele verschiedene Schädlingsbekämpfungsmittel anwenden sollen?“ wurden die Händler mit 59 % der Antworten am häufigsten genannt. An zweiter Stelle kommen die Nachbarn mit 22 %. Berater werden hier nur mit 6 % und allerdings auch nur von den Kontaktbauern benannt. Dies unterstreicht die oben genannten Zweifel an der Wirksamkeit der Beratungsarbeit. Aus eigenen Beobachtungen lässt sich hinzufügen, dass Landwirte sich erst dann an den Berater wenden, wenn sie untereinander und bei anderen geläufigen Quellen keine zufriedenstellenden Antworten auf akute Fragen und Probleme finden können. Unter den Händlern ist der Einzelhändler zu verstehen, der Verkäufer von Saatgut und Schädlingsbekämpfungsmitteln.

Saatgutverkäufer geben auch Empfehlungen für entsprechende chemische Behandlungsmittel des Saatguts. Das Gleiche gilt für die Verkäufer von Schädlingsbekämpfungsmitteln, auch diese geben Hinweise für den sachgerechten Einsatz. Hier spielt noch ein sozialer Aspekt eine wesentliche Rolle, nämlich dass die meisten Landwirte diese Betriebsmittel auf Raten kaufen, und dass die Händler in der Regel aus dem selben Dorf

stammen. Dies weist daraufhin, dass die Landwirte von diesen Händlern bis zu einem gewissen Grade wirtschaftlich und sozial abhängig sind, was dann auch ihr Übernahmeverhalten stark beeinflusst. Neben der chemischen Behandlung des Saatguts wurde erfragt, ob auch gegen Insektenbefall Schädlingsbekämpfungsmittel eingesetzt werden. 26 % antworteten mit Ja, 74 % mit Nein. Dies erstaunt, wo doch 87 % das Saatgut behandeln. Für den relativ geringen Insektizideinsatz bietet sich folgende Erklärung an:

In der Harran Ebene ist das Ökosystem im Vergleich zu anderen Bewässerungsgebieten der Türkei noch relativ intakt. 1998 gab es jedoch eine Epidemie von *Heliothis armigera*. Das war für die Landwirte eine gänzlich neue Erfahrung. Die meisten hatten nur wenig Wissen und Erfahrung zum Zeitpunkt der Schädlingsbekämpfung und zur Dosierung der Mittel. Sie kauften Pflanzenschutzmittel zu verhältnismäßig hohen Preisen und wendeten diese weitgehend unsachgemäß an. Als eine Folge davon waren viele Landwirte bei den Händlern zum Teil hoch verschuldet und mussten dafür auch hohe Zinssätze akzeptieren. Letztlich lohnte sich der Insektizideinsatz für die meisten der Landwirte nicht, und da in diesem Jahr auch der Garantiepreis für Baumwolle noch relativ niedrig ausfiel, führt es in einzelnen Fällen sogar dazu, dass Landwirte, die nicht gespritzt haben, einen höheren Gewinn erzielen, als diejenigen, die Insektizide eingesetzt haben. Seither tendieren die Landwirte in der Region dazu, keine Insektizidspritzung durchzuführen. Dies allerdings erleichtert es dem Pflanzenschutzdienst, für seine Empfehlungen zum integrierten Pflanzenschutz Akzeptanz zu finden.

Auf die Frage „Können Sie uns bitte nennen, welche Schädlingsbekämpfungsmittel Sie gegen welche Schädlinge anwenden?“ gaben 26 % sachgerechte Antworten, 61 % ordneten die Mittel jedoch falsch zu. Die Quote der Nichtanwender beschränkte sich bei dieser Frage auf 13 %. Wie aus Tabelle 3 entnehmbar ist, liegen die Kontaktbauern auch bei dieser Frage wieder deutlich besser als die Kontrolllandwirte. Die Kontrolllandwirte bezogen ihre Empfehlungen zum allergrößten Teil nicht vom Pflanzenschutzdienst.

Der Beratungsdienst gibt die Empfehlung, dass man die erste Bewässerung im Baumwollfeld nicht vor 35 Tagen nach der Aussaat vornehmen soll. Daher wurde die Frage gestellt: „Können Sie uns bitte sagen, wann Sie die erste Bewässerung der Baumwolle durchführen?“ 24 % der Befragten geben an, dass sie schon früher als nach 35 Tagen bewässern. Die Kontaktlandwirte und die Kontrolllandwirte unterscheiden sich hier kaum. Der richtige Bewässerungszeitpunkt wird von den Kontaktlandwirten jedoch deutlich häufiger genannt als von den Kontrolllandwirten, während schließlich bei den Angaben der zu spät liegenden Termine kaum noch Unterschiede erkennbar sind. Daraus kann man ersehen, dass der Einfluss des Beratungsdienstes auf die Kontaktlandwirte beim ersten Bewässerungszeitpunkt geringer ist als bei den folgenden Bewässerungen. Ein Grund dafür liegt vermutlich darin, dass die Berater über Bewässerungszeitpunkte weniger gut aus- und fortgebildet sind.

Der Pflanzenschutzdienst hat 1999 einen sogenannten Bauernbrief zu den verschiedenen Fragen der Baumwollproduktionstechniken entwickelt und diesen vor allem an die Kontaktlandwirte verteilt, um seine Klienten über die akuten Fragen gezielt zu informieren. Die Bauernbriefe sind auf guter Papierqualität gedruckt und mit farbigen Bildern verse-

**Tabelle 3:** Das Übernahmeverhalten der befragten Landwirte im Vergleich zwischen Kontaktlandwirten und Kontrolllandwirten

Art der Neuerungen	Antwortkategorien	Anzahl der befragten Landwirte					
		Insgesamt		Kontaktbauern		Kontrolllandwirte	
		abs.	v.H.	abs.	v.H.	abs.	v.H.
I. Zeit der Feldbestellung	a) gleich nach der Ernte	47	87,04	17	31,48	30	55,56
	b) erst im Januar	7	12,96	1	1,85	6	11,11
II. Chemische Behandlung des Saatguts	a) eine Sorte	12	22,22	4	7,41	8	14,81
	b) zwei Sorten	23	42,59	7	12,96	16	29,63
	c) drei Sorten	12	22,22	6	11,11	6	11,11
	d) Nichtanwendung	7	12,96	1	1,85	6	11,11
III. Informationsquelle	a) Händler	32	59,26	11	20,37	21	38,89
	b) Nachbarschaft	12	22,22	3	5,56	9	16,66
	c) Berater	3	5,56	3	5,56	0	-
	d) Nichtanwendung	7	12,96	1	1,85	6	11,11
IV. Schädlingsbekämpfung	a) ja	14	25,92	6	11,11	7	12,96
	b) nein	40	74,07	12	22,22	28	51,85
V. Gegen welche Schädlinge	a) richtig	14	25,93	7	12,96	6	11,11
	b) falsch	33	61,11	10	18,52	23	42,59
	c) Nichtanwendung	7	12,96	1	1,85	6	11,11
VI. Zeit der Bewässerung	a) früher als 35 Tage	13	24,08	3	5,56	10	18,52
	b) zwischen 35-40	17	31,48	9	16,67	8	14,81
	c) zwischen 41-45	19	35,18	6	11,11	13	24,07
	d) 46 Tage oder später	5	9,26	0	-	5	9,26
VII. Bauernbriefe	a) Ja	15	27,78	10	18,71	5	9,26
	b) Nein	39	72,22	8	14,81	31	57,41
VIII. Lesen der Bauernbriefe	a) gelesen	10	18,52	8	14,81	2	3,71
	b) nicht gelesen	5	9,26	2	3,70	3	5,56
	c) nicht erhalten	39	72,22	8	14,81	31	57,41
IX. Informationsquelle der Kontaktlandwirte	a) Anrufen			6	11,11		
	b) Bürobesuch			4	7,41		
	c) sowohl Händler, als auch Berater			2	3,70		
	d) nur Berater			3	5,56		
	d) nur Händler			1	1,85		
	e) Bekannte			2	3,70		

hen. Auf die Frage „Kennen Sie die Bauernbriefe, die der Pflanzenschutzdienst erstellt hat?“ antworteten nur 28 % der Befragten, dass sie diese Bauernbriefe kennen würden. Empfänger sind überwiegend die Kontaktlandwirte und darüber hinaus vor allem solche Kontrolllandwirte, die im Dorf irgend ein Amt bekleiden z. B. Dorfvorsteher, Vorsitzender des Bewässerungsverbands etc. Auch auf die Frage, ob sie denn den Bauernbriefe gelesen hätten, liegen die Kontaktlandwirte wieder häufiger als die Kontrolllandwirte. Schließlich verbleiben aber auch 15 % der Kontaktlandwirte, die angeben, die Bauernbriefe nicht erhalten zu haben. Dies könnte heißen, dass der Pflanzenschutzdienst seine Bauernbriefe nicht systematisch und lückenlos an die Kontaktlandwirte verteilt hat.

Zum Schluss wurden die Kontaktlandwirte noch gefragt: „Wie Sie wissen, werden die Berater im nächsten Jahr mit einem Kontaktlandwirt aus einem anderen Dorf arbeiten. An wen werden Sie sich dann wenden, wenn Sie ein Problem im Baumwollanbau haben?“ 11 % würden den Berater telefonisch um Rat fragen, 7 % würden ihn in seinem Büro aufsuchen. Sowohl den Händler, als auch den Berater fragen, würden 4 %. Nur den Händler fragen, würden 1,85 %. Dies lässt sich als ein positiver Indikator für die Wirkung des Pflanzenschutzdienstes verstehen, sind die Landwirte doch so motiviert, bei neuen Fragen aktiv den Rat des Pflanzenschutzdienstes zu suchen. Vermutlich sind die Nennungen der Informationsquellen bei den Fragen 3 und 9 deshalb so unterschiedlich, weil Frage 3 nach einem tatsächlichen Verhalten in der Vergangenheit und Frage 9 dagegen nach einem hypothetischen Verhalten in der Zukunft fragt. Ob die Antwort auf die hypothetische Frage künftig mit dem tatsächlichen Verhalten übereinstimmen wird, lässt sich nicht voraussagen. Außerdem sind bei Frage 9 nur die Kontaktlandwirte gefragt worden, bei der Frage 3 jedoch beide Gruppen und so kann man indirekt vermuten, dass sich hier eine positive Wirkung der Arbeit des Pflanzenschutzdienstes bei den Kontaktlandwirten deutlich macht.

## **6 Konsequenzen**

Aus den Untersuchungsergebnissen werden einige der Probleme sichtbar, mit denen der Pflanzenschutzdienst vermutlich auch in der künftigen Arbeit konfrontiert sein wird. Einige der offensichtlichen Probleme, für die sich mögliche und vermutlich realistische Lösungen anbieten, werden hier nach zwei Punkten untergliedert dargestellt.

### **6.1 Faktoren, die der Pflanzenschutzdienst direkt beeinflussen kann**

Im Folgenden werden 5 Faktoren mit Verbesserungsvorschlägen dargestellt:

#### **6.1.1 Merkmale des eingesetzten Modells zur Beratung im integrierten Pflanzenschutz**

Das weiter oben beschriebene Modell wurde vom Pflanzenschutzamt in der Provinzhauptstadt zentral geplant, vorbereitet und realisiert. Die Zielgruppe wurde in der Planung und Vorbereitung des Modells nicht einbezogen. Um die Effizienz des Beratungsansatzes zu steigern, wird empfohlen, dass die Führungskräfte des Pflanzenschutzdienstes, zusammen mit Beratern, über das Programm und die inzwischen vorliegenden Ergebnisse diskutieren und eine Fortbildung über mögliche Vorteile der Zielgruppenpartizipa-



tion auch bei Planung und Durchführung von Beratungsprogrammen konzipieren und durchführen. Neben der mangelnden Partizipation der Zielgruppen hat das Modell aber auch eine Reihe von positiven Eigenschaften. Während drei Mitglieder eines Berater-teams die Kontaktlandwirte in den vorgesehenen Dörfern besuchen, nehmen die übrigen zwei Aufgaben im Büro wahr. Die auf die verschiedenen Berater-teams verteilten jüngeren und weniger erfahrenen Berater erweiterten ihr Wissen unter der Betreuung der älteren und erfahreneren Kollegen und verbesserten ihre Erfahrungen in der praktischen Beratungsarbeit. Auch können einzelne Teammitglieder in den Sommerurlaub gehen, so lange die Arbeit von den übrigen fortgesetzt wird. Günstig in der gewählten Methodik wirkt sich aus, dass der Berater die Kontaktlandwirte regelmäßig im Betrieb und auf ihren Baumwollfeldern besucht, und dass daraus ein Vertrauensverhältnis entsteht, das die Übernahme der empfohlenen Neuerungen wesentlich erleichtert.

Aus diesem geschilderten Modellprojekt lässt sich also auch folgern, dass die türkische Officialberatung ihre Effizienz noch nachhaltig steigern kann und dies, ohne personelle Kapazitäten aufzustocken und ohne zusätzliche finanzielle Unterstützung zu erhalten. Es reicht aus, die bestehenden Ressourcen in ein gut konzipiertes Programm und in einem geographisch begrenzten Gebiet, bezogen auf vorrangige Fragen der Produktionstechnik konzentriert einzusetzen. Bringt der Einsatz der Empfehlungen z. B. des integrierten Pflanzenschutzes den Landwirten wesentliche finanzielle Vorteile, so kann man berechtigt auf einen selbsttragenden Diffusionsprozess unter den Landwirten vertrauen. Die Entwicklung eines wirksamen Programms in diesem Sinne würde allerdings wesentlich erfolgsträchtiger, wenn die Zielgruppen von Anfang an die Möglichkeiten erhielten, an der Planung und Gestaltung des Programms aktiv mitzuwirken.

### **6.1.2 Ziele des Modells**

Die unzureichende Situationsanalyse führte leider dazu, dass die Ziele der Beratungsarbeit nicht genügend realistisch und klar festgelegt wurden. Um die Wirksamkeit des gewählten Beratungsansatzes zu steigern, sollten in Zukunft bei der Formulierung von Zielen die Bedürfnisse und Ansichten der Zielgruppe stärker mit einbezogen werden. Auch war eine Evaluierung des Modellprojekts nach Ende jeweils einer Vegetationsperiode im Programm nicht vorgesehen, es war weder eine Fachkraft für die Evaluierung, noch ein Budget dafür vorhanden. Trotzdem ist es den einzelnen Beratern sehr wohl möglich, die eigene Beratungsarbeit innerhalb der bestehenden Kapazität selbst zu evaluieren. Eine entsprechende Fortbildung würde dies wesentlich erleichtern.

### **6.1.3 Methodenfragen**

Noch wichtiger als klare Ziele sind wohldurchdachte und sachgerechte Methoden der Beratungsarbeit. Ein besonders kritischer Punkt für den Erfolg des Modells ist die Auswahl der Kontaktlandwirte, da die Arbeit mit ihnen sozusagen der harte Kern des Modells ist. Trotz einiger weniger Probleme, ist dem Pflanzenschutzdienst insgesamt eine glückliche Wahl der Kontaktlandwirte gelungen.

So war es schon günstig, dass sich die Berater-teams selbstständig konstituieren konnten, und dann – unabhängig von der Leitung – die Kontaktlandwirte auswählen durften. Sie

konnten damit ihre lokalen Kenntnisse und Beziehungen konstruktiv einbringen und waren gleichzeitig für ihre Beratungsarbeit besser motiviert. Allerdings wurden für die Wahl der Kontaktlandwirte auch keine klaren Kriterien vorgegeben und dies wäre für die Zukunft allerdings unbedingt zu empfehlen. Die Auswahlkriterien sollten schriftlich vorliegen und für alle Beraterteams verbindlich sein. Darüber hinaus sollten die übrigen Landwirte im Dorf, soweit wie möglich, in das Auswahlverfahren einbezogen werden.

So gab es auch einige Kontaktlandwirte, die Vereinbarungen mit den Beratern nicht eingehalten haben. Jedes Beraterteam hat dies dann unterschiedlich gehandhabt. Ein Team z.B. hat einen neuen Kontaktlandwirt gewählt, ein anderes nicht. Die Beratungsorganisation sollte eine gewisse Beratungskapazität für unvorgesehenes Verhalten von Kontaktlandwirten vorhalten, um dann jeweils angemessen zu reagieren und ausgefallene Termine ersetzen zu können.

Zwar wurde es gewünscht, dass die Felder der Kontaktlandwirte im Sinne von Demonstrationsfeldern wirken, dafür wurden jedoch keine besonderen Aktivitäten vorgesehen und so blieb die Verbreitungswirkung eher unsystematisch und den örtlichen Zufällen überlassen.

Im vorgefundenen Programm konzentrierte sich die Arbeit der Berater im Wesentlichen auf technische Empfehlungen gegenüber den Kontaktlandwirten. Eine besondere Schulung in den Aufgaben eines Kontaktlandwirts gegenüber den übrigen Berufskollegen im Dorf fand jedoch nicht statt. Dies wäre in künftigen Programmen unbedingt vorzusehen. Was dagegen gut ankam, war ein im Glasrahmen überreichtes Zeugnis für erfolgreiche Kontaktlandwirte, das persönlich auf dem Hof überreicht wurde.

Die hier vorgetragenen Beobachtungen und abgeleiteten Empfehlungen müssten normalerweise aus einer kritischen Selbstreflektion innerhalb der Beratungsteams und aus fortlaufender Situationsanalyse und begleitender Evaluierung entstehen und in die weitere Anpassung des Modellprojekts einfließen.

#### **6.1.4 Selbstevaluierung**

Das Ziel von allen Bemühungen der Evaluierung sollte letztlich immer sein, die Berater durch das Erkennen der Ursachen von Misserfolgen und durch die Feststellung von Erfolgen für die Beratungsarbeit zu motivieren.

Ergebnisse von Auswertungsgesprächen und Beobachtungen sollten systematisch und schriftlich festgehalten werden. Die Berichtsformulare sind dafür schon ein guter Anfang, jedoch müssten sie auch systematisch ausgewertet werden. Dies und die kritische Eigenkontrolle könnten zusammen mit der Beteiligung der Zielgruppe an der Projektarbeit den Erfolg des Modells wesentlich steigern. Evaluierung sollte ein fester Bestandteil schon in der Planung dieses Modellprojektes sein. Auch innerhalb der bestehenden Kapazität kann Evaluierung erfolgen, sind doch die einzelnen Berater selbst dazu in der Lage. Hilfreich dazu wäre es, wenn die Führung die Erfolgsindikatoren klar benennen könnte, dann könnte man auch versuchen, sie jeweils zu verfolgen. Zusätzlich sollte ein einfaches und überschaubares Berichtswesen eingeführt werden, in dem, nicht wie sonst üblich, über Aktivitäten berichtet wird, sondern in dem vorrangig wirkungsorientier-

te Kriterien erfasst werden. Gelegentliche unabhängige Stichprobenerhebungen könnten die Ergebnisse der Selbstevaluierung verifizieren und validieren.

### **6.1.5 Fortbildung der Berater**

Bei der bisher durchgeführten Fortbildung der Berater ging es in erster Linie um produktionstechnische Fragen (Anonymus 2000). Neben den Pflanzenschutzthemen sollten auch die weiteren Themen der integrierten Schädlingsbekämpfung in die Fortbildung einbezogen werden. Themen der Beratungsmethodik und Fragen des Verhaltens und der Verhaltensänderung bei den Zielgruppen werden noch gar nicht behandelt. Von daher ist es leicht verständlich, dass bei den wöchentlichen Auswertungsgesprächen die produktionstechnischen Fragen und dabei insbesondere die Pflanzenschutzmassnahmen dominieren. Es ist jedoch zu empfehlen, dass Fortbildungskurse sich an den Zielen des eingesetzten Beratungsmodells ausrichten, so dass die Berater in die Lage versetzt werden, die in der Praxis tatsächlich auftretenden Probleme zu lösen. Dazu gehören neben der Fachkompetenz auch Kommunikationsfähigkeit und soziale Kompetenz und auch dies müsste Gegenstand von Fortbildung und laufender Evaluierung werden.

Trainer für die Fortbildung sollten möglichst aus der Mitte der Beratungsteams heraus gewählt werden und ihrerseits vorrangig in am Bedarf orientierten Themen trainiert werden. Wenn das Budget es zulässt, wäre es sehr empfehlenswert, für die Trainer eine externe Supervision hinzuzuziehen.

## **6.2 Faktoren, auf die der Pflanzenschutzdienst keinen direkten Einfluss hat**

Der Gesamterfolg der Entwicklungsbemühungen wird wesentlich durch andere Faktoren bestimmt, deren direkte Beeinflussung über die Möglichkeiten des Beratungsdienstes hinausgehen. Die Beratung kann durch Koordination und Kooperation jedoch einen starken mittelbaren Einfluss auch hier geltend machen. Begrenzende Faktoren der Entwicklung in dieser Region sind vor allem die mangelnde Kreditverfügbarkeit, Schwierigkeiten beim Absatz der Baumwolle, der allgemeine schlechte Bildungsstand der Landwirte und die für die Verbesserung der Lebenslage von Kleinlandwirten eher als ungünstig anzusehenden politischen Rahmenbedingungen und Grundbesitzverhältnisse.

Im persönlichen Gespräch äußerte der Leiter des Pflanzenschutzdienstes die Absicht, dass man im kommenden Jahr mit den übrigen staatlichen Organisationen enger zusammenarbeiten will und die Beratungsarbeit mit diesen besser koordinieren möchte.

Abschließend kann man sagen, dass das beschriebene Modell des Pflanzenschutzdienstes schon jetzt Erfolge zeigt und auch in anderen Provinzen der Türkei mit Bewässerungslandwirtschaft dann vermutlich erfolgreich einsetzbar ist, wenn zusätzlich die angeführten Verbesserungsvorschläge in Betracht gezogen werden.

# Evaluation of the Model for Integrated Pest Management in Cotton by Contact Farmers in the Harran Plain

## Abstract

This study is conducted to evaluate the extension project "Integrated pest management in cotton cultivation by contact farmers", which was realized by the office for plant protection 1999 in the provincial city Sanliurfa, considered as centre of the South Eastern Anatolia Project. Through a simple evaluation model the goals and working method of the extension organization have been examined. In addition, a set of questions around IPM was tested concerning goals, methods applied, attainment of the goals, and the behaviour of the target group for the adoption of IPM innovations etc. With these questions interviews with 54 farmers in 18 villages and with 12 advisors have been realised. The results of the investigation were presented separate for the advisor and client of system. The majority of the advisors have long local professional experience and appreciate their clients and their job. They are able to draw conclusions from their own work. The knowledge of the contact farmers in the technical questions is substantially higher than that of the control farmers. In addition, their adoption rate of the innovations recommended by the advisory service, lie over the rate of the control farmers. The consequences were summarized under two factors: Factors that the extension service can affect directly and factors, on which the extension service does not have a direct influence.

Keywords: Evaluation, Agricultural Extension, Integrated Pest Management, Contact Farmers, Cotton, Turkey

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## Access to Rural Land in Eastern Ethiopia: Mismatch between Policy and Reality

K. Belay\*<sup>1</sup> and W. Manig<sup>2</sup>

### Abstract

This paper explores the different means of access to land in three districts of Eastern Ethiopia. Data collected from a random sample of 313 heads of households were used in the study. The results show that as land is state-owned and farmers have only usufruct rights on land allocated to them by local authorities, access to additional cultivable land is achieved through land rental transactions (mainly in the form of sharecropping) and land borrowing. Another important finding of this study is that the average land holding has been declining over the years as a result of increased demographic pressure, resulting in individual farm units that are generally too small to be economically viable. The study also makes it clear that the issue of access to cultivated land is inextricably linked to other important factors such as availability of credit, market integration, effective advisory service, etc.

**Keywords:** Access to land; land borrowing; land fragmentation; land redistribution; land renting; land tenure; state ownership; usufruct rights

### 1 Introduction

Ethiopia, with a population of 70.7 million in 2003 is the third most populous country in Africa just behind Nigeria and Egypt (WALTA INFORMATION CENTER, 2003). Its economy is based on agriculture, which accounts for about 50% of GDP, 90% of exports, and 85% of total employment (MEDAC, 1999). The Ethiopian agriculture is virtually small-scale, subsistence-oriented and crucially dependent on rainfall. About 90 percent of the country's agricultural output is generated by subsistence farmers who use traditional tools and farming practices (OMITI *et al.*, 2000). Low productivity characterises Ethiopian agriculture. The average grain yield for various crops is less than 1 metric ton per hectare (BELAY, 2002). Available evidence shows that yields of major crops under farmers' management are still by far lower than what can be obtained under research managed plots (HABTEMARIAM, 2003). This is a clear indication of the gap, which exists between researchers and farmers. The livestock sub-sector plays an important role in the Ethiopian economy. The majority of smallholder farms depend on animals for draught power, cultivation and transport of goods. The sub-sector makes also significant contribution to the food supply in terms of meat and dairy products as well as to export

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\* corresponding author

<sup>1</sup> Kassa Belay, Associate Professor, Alemaya University, P.O. Box 138, Dire Dawa, Ethiopia

<sup>2</sup> Winfried Manig, Professor, Institute for Rural Development, University of Goettingen, Waldweg 26, 37073 Goettingen, Germany

in terms of hides and skins which make up the second major export category. However, the productivity of the sub-sector is decreasing as a result of poor management systems, shortage of feed and inadequate health care services (BELAY, 2004).

Over the last two decades, Ethiopian agriculture has been unable to produce sufficient quantities to feed the country's rapidly growing population. As a result, the country has been an important recipient of food aid and importer of commercial food grain. In recent years food aid has been accounting for a significant proportion of the total food supply in the country. For instance, Ethiopia received 726,640 metric tons of food aid yearly over the period 1985-2000 (FDRE, 2002). This represents about 10% of the national food grain production. Recent studies on Ethiopian agriculture found that low technical inputs, outmoded farming practices, inappropriate policies, tenure insecurity, as well as the degradation of the environment and its productive potential are the underlying reasons for poverty, food insecurity and increased vulnerability to drought in rural Ethiopia (DESSALEGN, 1999; OMITI *et al.*, 2000; KEBEDE, 2002; HABTEMARIAM, 2003; BELAY, 2004). The average land holding is only about one hectare per household and the population growth rate is creating increasing pressure on land and other natural resources (MEDAC, 1999; CENTRAL STATISTICAL AUTHORITY, 2002). In fact, more than 80 percent of Ethiopia's population live in the highlands where the population pressure on arable land has always been immense. This has resulted in smaller and fragmented individual land holdings which, in turn, led to the cultivation of marginal lands, such as steep slopes, hills, forest lands and permanent pasture lands and exacerbated the effects of recurrent droughts and famines (BELAY, 2004). It should be noted that, at the household level, the problem of food insecurity will be compounded in the event that farmers own landholdings less than the area required for minimum food production and have to rent-in cultivable land, which requires them to pay rent (in kind or cash) to the land rights-holders.

In a country like Ethiopia where agriculture employs the vast majority of the population, land is an important economic resource for the development of rural livelihoods. Available empirical evidence on land rights and land administration in Ethiopia shows that the land tenure systems have been an important determinant of investment in land improvement measures and sustainable use of land (ALEMU, 1999; DESSALEGN, 1999; KEBEDE, 2002). In Ethiopia, land has been owned by the state since 1975. Following the 1975 land reform proclamation, the Marxist military regime (1975-1991) prohibited tenancy relations, such as sharecropping and renting. The current government lifted these restrictions and at present the different means used to acquire access to land include gifts or borrowing, fixed rent tenancy and share tenancy (PENDER and FAFCHAMPS, 2001)<sup>1</sup>. The existing empirical literature on land tenure arrangements in Ethiopia is dominated by studies conducted in the central and northern parts of the country. This paper examines the current land tenure arrangements in Eastern Ethiopia.

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<sup>1</sup> In the context of this paper access to land simply means that a person is able to make use of the land. Access rights do not necessarily include ownership or possession (BRUCE, 1998), but usually do include some decision-making power over the production process, products, and use of that land.

The rest of this paper is organized in four sections. Section 2 focuses on the study area and the method employed in the study. Section 3 discusses the concept and implication of land tenure systems as well as the evolution of the land tenure systems in Ethiopia. Section 4 presents the results of the study. The final section summarizes the main findings and draws appropriate conclusions.

## 2 Research Design and Data Collection Method

### 2.1 Description of the study area

The study was conducted in three districts of the Harar Highlands, Eastern Ethiopia. The Harar highlands are part of the south-eastern Ethiopian Highlands. They fall approximately within a demarcation of 40° 45' E to 42° 20' E longitude and 8° 50' N to 9° 30' N latitude and cover an estimated area of 15,000 km<sup>2</sup> (AMARE, 1980). The topography is characterized by undulating relief and dissected plateaux. The altitudes range between 1,500 and 3,400 meters above sea level (m.a.s.l.). The most important agricultural zone is the 1,800 to 2,500 meters above sea level zone. Areas above 2,500 m.a.s.l. represent about 5% of the highlands, and are not as intensively cultivated as the 1,800 to 2,500 m.a.s.l. zone (POSCHEN-EICHE, 1987). The Harar Highlands have in general favourable climatic conditions for agriculture, though this suitability declines from north to south and from west to east, governed partly by the topography and rainfall respectively. The average annual rainfall in the different districts of the Harar Highlands ranges from 700 to 1,200mm (HABTEMARIAM, 2003). The area exhibits a bimodal pattern of precipitation, with the 'big' rains that constitute about two-thirds of the annual total rainfall amount falling between July and September, and the 'small' rains between March and May.

The Harar Highlands are located in the Eastern Hararghe Zone of the Oromia National Regional State (ONRS)<sup>2</sup>. The ONRS is the largest of the nine regional states of Ethiopia. The population of Eastern Hararghe zone is estimated to be 2 million (ZOPED, 2001). The majority of the population (over 90%) were reported to live in rural areas and depended directly or indirectly on agriculture for their livelihood. Due to the high population pressure in rural areas, farmers cultivate smallholdings. The farming system is a typical mixed crop-livestock. The principal agricultural activity is crop cultivation with livestock rearing as a secondary activity. Crop production sub-system is characterized by multiple cropping, especially mixed and relay cropping of different species. The major cash crops are chat (*Catha edulis*) and coffee and in some locations vegetables<sup>3</sup>. Major

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<sup>2</sup> With the change in government in 1991, on the basis of ethnic, linguistic and cultural identity, the country was divided into 9 semi-autonomous regional states, one federal capital (Addis Ababa) and one special administrative division (Dire Dawa). According to the Ethiopian Federal Democratic Republic administrative hierarchy, the regional states are divided into zones, districts and Peasant Associations or *kebeles* (local administration units), in that order.

<sup>3</sup> *Chat* is a natural stimulant plant, which reaches heights from 3 to 7 meters. Fresh chat leaves, which are typically chewed like tobacco, produce a mild cocaine- or amphetamine-like euphoria that is less potent than either substance. Chat is widely used in eastern and southern parts of the country.



food crops include sorghum, maize, bean, potato, sweet potato and to a lesser extent wheat and barley (HABTEMARIAM, 2003). The principal livestock species are cattle, goats, sheep, and donkeys.

## 2.2 Sampling design

A three-stage sampling technique was used to select the sample farmers. In the first stage, among the fourteen districts found in the Harar Highlands, three districts with similar agricultural production systems and fairly similar access to major road and urban centres were selected based on information from ZOPED (2001). In the second stage, one Peasant Association (PA) from each district, with comparable characteristics with other PAs in the other districts was selected<sup>4</sup>. In the final stage, household heads in the selected PAs were listed down and given the limited resource and time at the disposal of the researcher, a total of 313 farm households (about 16% of farm households in each PA) were selected randomly using probability proportional to sample size sampling technique (Table 1).

**Table 1:** Number of Households and Sample Size by Peasant Association

<i>District</i>	<i>Peasant Association</i>	<i>Total number of households</i>	<i>Sampled households</i>
Deder	Medejalela	679	110
Gursum	Awebere	631	102
Kombolcha	Tula	625	101
Grand total		1935	313

## 2.3 Method of data collection

Field research was conducted from March to May 2003. A structured questionnaire was used for the field interviews. The questionnaire was pre-tested by administering it to selected respondents. On the basis of the results obtained from the pre-test, necessary modifications were made on the questionnaire. Five technical assistants with rich experience in survey research work administered the structured questionnaire. In addition to the questionnaire survey, discussions were made with randomly selected farmers and key informants including community leaders, development workers and representatives of non-governmental organizations. These informal techniques helped to acquire useful and detailed information, which would have been difficult to collect through the questionnaire survey.

<sup>4</sup> A Peasant Association (PA) is a territorial organisation with broad administrative and legal powers encompassing 800 hectares or more.

### 3 Conceptual and Historical Background

#### 3.1 Concept and implication of tenure systems

Land tenure issues have become increasingly important in the developing world. Problems such as high population pressure, increases in resource degradation, recurrence of food shortages, and the low capacity of the non-farm sector to siphon-off the excess population from rural areas have made land tenure a politically sensitive issue. A land tenure system cannot be understood except in relationship to the economic, political, and social systems which produce it and which it influences (BRUCE, 1998). DOWNS and REYNA (1988) note that "land tenure systems may be thought as sets of rules- at sometimes customs, at others laws- concerning people's rights to land, together with the institutions that administer these rights and the resultant ways in which people hold the land". Rules of tenure define how property rights to land are to be allocated within societies. They define how access is granted to rights to use, control, and transfer land, as well as associated responsibilities and restraints (FAO, 2002). Hence, land tenure is more about property rights in land and the way such rights are administered.

The nature and strength of property rights profoundly condition economic decision making. There is strong consensus that well-defined and well-enforced property rights internalize externalities and thereby, guide decision-makers to consider the social consequences of their actions (FURUBOTN and PEJOVICH, 1972; BRUCE, 1998; ALEMU, 1999). There is also widespread evidence that well-defined and well-enforced property rights on land are the main instruments for increasing tenure security, empowering a flourishing land market, facilitating the use of land as collateral in credit markets, enhancing the sustainability of resource use, and preventing environmental degradation (ATWOOD, 1990; DEININGER and BINSWANGER, 1999; PLATTEAU, 2000; FAO, 2002). This illustrates that with exclusive and secure property rights, resource depletion is internal to the owners/users, while under open access it is external to the users.

Rights to use and/or of control over land are central to the lives of rural populations especially in countries where the majority of the population lives in rural areas and the main sources of income and livelihood are derived from land. In areas where other income-earning opportunities are limited, access to land determines not only households' level of living and livelihood, but also food security. The extent to which individuals and families are able to be food-secure depends in large part on the opportunities they have to increase their access to assets such as land, as well as access to markets and other economic opportunities (FAO, 2002). Though there is an old and large literature on land tenure systems, studies aimed at exploring the direct links between land tenure and food security are few and far between. According to MAXWELL and WIEBE (1999), land tenure and food security have not traditionally been the subject of integrated research, in part because land tenure is defined primarily in legal institutional terms, while food security is generally defined in terms of food consumption and bio-medical criteria. In recent years, however, there is an increasing interest to investigate the implications of different land tenure systems for food security (DESSALEGN, 1999; MAXWELL and WIEBE, 1999; FAO, 2002).

### 3.2 Review of the land tenure systems in Ethiopia

A historical survey of the land tenure systems in Ethiopia reveals that since the 1975 land reform, all rural lands have been owned by the state. Prior to the 1975 land reform, diverse forms of land tenure systems that emanated from different social, political, economic, cultural and historical conditions co-existed in the country. A closer look at the types of tenure systems across the country shows that there were regional variations. In the north, a 'communal' or kinship tenure system, with periodic redistribution of communal land to accommodate new claimants, was in place, resulting in few landless farmers and perpetual fragmentation of holdings. Whereas in the south, a private ownership system was predominant and land was concentrated in the hands of members of the royal family, persons of influence as well as military, civil and ecclesiastical officials. The land tenure system in the southern regions was therefore characterised by a predominant private ownership pattern, a wide-spread and exploitative landlord -tenant relationship, tenure insecurity, widespread landlessness, as well as large proportion of tenants with miserable living conditions (ALEMU, 1999; MENGISTEAB, 1990)<sup>5</sup>.

Following the downfall of the Imperial regime in September 1974 the military government which took power embarked on the establishment of a state-controlled socialist economy. As part of its economic policy it enacted a land reform law on March 4, 1975. Through this proclamation all rural land became the "collective property of the Ethiopian people" (the Ethiopian State). The proclamation banned private ownership of rural land and its transfer by sale, exchange, succession, mortgage, lease or other means. However, the proclamation made it clear that any person willing to cultivate land shall be allotted a family holding which may not exceed 10 hectares over which he/she would have only usufruct rights. Accordingly, land in excess of 10 hectares and large scale mechanised farms were expropriated and the latter were organised into state farms or co-operatives and in some cases distributed to landless farmers.

Available evidence shows that the great opportunity that the land reform created to develop the agricultural sector was nipped in the bud by a series of misguided policies. These included, among others, coercing farmers to join producer co-operatives, tenure insecurity and diminution of holdings through redistribution of land, state control of grain marketing as well as farmers' obligation to sell a fixed proportion of their produce (in form of quotas) at fixed prices, which were by far lower than the free market prices, to the state-owned Agricultural Marketing Corporation (MENGISTEAB, 1990; KEBEDE, 2002; BELAY, 2004). These authors argue that the policy measures resulted in farmers' dissatisfaction and stifled agricultural development.

The military government was overthrown on the 28<sup>th</sup> of May 1991. The Transitional government which replaced it adopted an economic policy in November 1991, which espoused the main principles of a free market economic system. The policy document emphasised a limited economic role for the state and established a basis for liberalisation

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<sup>5</sup> NEGASH (1997) cited government sources that reported that in southern Ethiopia up to 50 percent of the peasants were tenant and in the north as much as 90 percent of the peasants owned the land they tilled.

of the economy. Regarding the issue of land ownership rights, the policy document stated that “until the issue is settled by a referendum after the transition period, there will be no changes in the policy of public ownership of rural land” (TGE, 1991). It was only in 1994, with the drafting of the new constitution, that it became apparent that the Ethiopian People’s Revolutionary Democratic Front (EPRDF), the ruling party, was in favour of maintaining state ownership<sup>6</sup>. Sub-article 3 of article 40 of the new constitution (FDRE, 1995) states: “The right to ownership of rural and urban land, as well as of all natural resources, is exclusively vested in the State and the peoples of Ethiopia. Land is a common property of the Nations, Nationalities and Peoples of Ethiopia and shall not be subject to sale or to other means of exchange”.

A closer look at the EPRDF’s land tenure system reveals that it is not fundamentally different from that of the military regime. Like the military regime’s land ownership policy, the current land policy states that land is state-owned and cannot be sold or exchanged or mortgaged. One noticeable difference between the two policies is that, in the current system, farmers have not only user rights on the land, but they can also rent it out to other people.

According to the official statements of the government, state ownership of land helps prevent: large numbers of farmers from selling, mortgaging or transferring their land and becoming landless; land concentration in the hands of a rich peasantry; and urban and non-indigenous businessmen and elite from buying up rural land, leading to an increase of tenancy, eviction, rural-urban migration and political unrest (MOIPAD, 2001).

Recent studies suggest that in the Ethiopian context, state ownership of land has resulted in fragmentation of agricultural holdings (NEGASH, 1997; DESSALEGN, 1999; EEA/EEPRI, 2002; KEBEDE, 2002). This has in turn seriously imperilled the economic and social viability of holdings. From the foregoing discussion it can be concluded that the issue of land ownership rights remains to be one of the contentious problems that Ethiopian agriculture has to live with. In reality, because of the fact that land constitutionally belongs to the state, farmers are rather sceptical to invest in long-term land improvement practices (such as tree planting, construction of anti-erosion barriers, building of ditches and furrows). In this regard, recent studies in different parts of the country found that tenure insecurity generated by fear of further redistribution was the principal factor explaining farmers’ unwillingness to invest effort in measures to improve soil conservation and enhance fertility (OMITI *et al.*, 2000; EEA/EEPRI, 2002; KEBEDE, 2002; MULUGETA *et al.*, 2001).

The current government’s land policy contradicts with its officially stated objective of building a free market economic system, since this could hardly be possible without secured property rights including land rights vested in citizens. The reality is that in many rural areas there are emerging informal land markets that signal farmers’ preference (KEBEDE, 2002; PENDER and FAFCHAMPS, 2001).

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<sup>6</sup> Following national elections held on May 7, 1995 the EPRDF won overwhelming victory and formed a national government on August 21, 1995 thereby replacing the Transitional Government, which was in power for almost four years.

## 4 Results and Discussion

Table 2 presents summary statistics of some household characteristics of the sample respondents. The average family size of the sample farmers was 6.92, a figure which was above the national average of 5 persons (CENTRAL STATISTICAL AUTHORITY, 2002). About 94% of the sample households were male-headed and the remaining (6%) were female-headed. The survey shows that the average dependency ratio was 1.52, i.e., each economically active person in a family supported more than one economically inactive person<sup>7</sup>. The average age of the sample household head was about 40 years. However, this average conceals differences in age among sample household heads, which ranged from 16 years to 80 years. About 69% of the respondents were illiterate while about 10 percent could only read and write and the rest (about 21% of the sampled farmers) had formal schooling of different levels. With regard to the marital status of the sample respondents, 93.5% were married, 5.5% were widowed and the remaining (1%) were single. The majority of the respondents (98.4%) were Moslems and the rest were Christians.

**Table 2: Some Household Characteristics (Mean and Standard Deviation)**

Variable	<i>Peasant Association</i>			Total n=313
	<i>Awebere</i> n=102	<i>Medejalela</i> n=110	<i>Tula</i> n=101	
Farm size (ha)	1.44±0.86	0.85±0.38	1.04±0.89	1.10±0.78
Household size	7.01±2.44	6.40±2.34	7.40±3.11	6.92±2.67
Livestock holding (TLU)	1.77±1.49	1.90±1.56	2.54±1.67	2.07±1.60
Age of household head	39.27±12.28	40.27±12.83	41.34±12.64	40.29±12.58
Draft oxen (head)*	1.51±0.93	1.28±0.51	1.14±0.65	1.32±0.75
Dependency ratio	1.68±1.14	1.39±0.92	1.49±1.12	1.52±1.06

\* Mean values are computed for those respondents who reported to have owned oxen at the time of the survey. About 58 percent of sample respondents in Awebere reported that they did not own oxen at the time of the survey. The respective percentages for sample respondents in Medejalela and Tula are about 67% and 65%.

Source: Survey results

The average landholding of the sample respondents is 1.1 hectares. The size of the land owned by the respondents, of course, varies from a minimum of about 0.1 hectare to a maximum of 7.25 hectares. It is also important to note that 10% of the respon-

<sup>7</sup> Dependency ratio is the ratio of the number of children below 15 years of age, disabled members and elders above 65 years of age to the number of economically active family members (15-65 years of age).

dents owned less than 0.42 hectares of land. This clearly shows the existence of “latent landlessness” in the study area in that land which is the major source of income and subsistence is in short supply relative to the large family size of households. Similarly, 50% of the respondents had less than 0.87 hectares of land and only 10% of the respondents had a farm size of larger than 2 hectares.

In response to a question regarding the size of their land holding since the change in government in 1991, 13% of the sample respondents reported that it had declined where as the remaining (87%) stated that it had remained the same. The principal reason for the reduction in the average land holding as reported by the sample respondents was the increase in population in the area and the ensuing demand for land by newly formed households. The survey results show that as there is no spare arable land in the study area, access to cultivable land by those who reached the age of adulthood and/or newly-married members would be through sharing land from their parents. In this respect, about 99% of the respondents reported that the only way to get access to cultivable land is to share it from parents. Whereas the remaining (1%) respondents indicated that newly formed households cultivate marginal areas, steep and fragile lands. In the current state of affairs, an increase in rural population gives rise to a reduction in the size of family holdings and ultimately in individual farm units that are generally too small to be economically viable. It is important to note here that the shortage of arable land is a central issue which needs to be addressed if peasant agriculture is to play a leading role expected of it in the country's food security strategy. Under the current situation, state ownership of land and the associated policy measures exacerbate the problem of land fragmentation.

The average livestock holding per household was 2.07 TLU for the whole sample and the respective figures for sample respondents from Awebere, Medajalela and Tula are 1.77 TLU, 1.9 TLU and 2.54 TLU<sup>8</sup>. The importance of livestock for subsistence, as a source of cash and as a store of wealth, is contingent upon the number and types of animals owned, the availability of feed and water, and the owners' management skill. In this respect, about 95% of the respondents reported that lack of animal feed as the most important constraint for livestock production. The corresponding percentages for Awebere, Medajalela and Tula are 93%, 99% and 93%.

Seventy-seven respondents (about 25% of the total) reported that they rented-in land (Table 3). The average size of the rented-in land was 0.53 hectares. Seventy-six of the 77 renter households were male-headed. Of the 77 respondents who reported to have rented-in land, 93.5% indicated that their principal reason for renting-in land was the small size of their holdings. In this respect, the survey results reveal that the renter households had an average land holding of 0.89 hectares. The respective figure for the non-renter sample households was 1.17 hectares. Other reasons cited by the respondents for renting in land include, to assist the land rights-holders who because of disability, old age, lack of working capital and other factors could not cultivate their

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<sup>8</sup> One Tropical Livestock Unit (TLU) is equal to 250kg. The TLU values for different species of animals are: 1 for camel; 0.7 for cattle; 0.8 for horse/mule; 0.5 for donkey; 0.1 for goat/sheep (ILCA, 1992).

land (18.2%), availability of extra cash (15.6%), availability of extra draught power (9.1%), and availability of extra labor (5.2%). The remaining (6.5%) failed to specify the reasons for renting-in land. The survey results show that the sample respondents who rented in land participated in rental transaction on average for a period of five years since the down fall of the military regime. However, the great majority of them (72%) reported that over the years it has become difficult to find land to rent mainly as the result of increasing demand for the same.

**Table 3:** Percentage distribution of respondents who rented-in land by reasons for renting in land \*

<i>Duration of the contract</i>	<i>Peasant Association</i>			<i>Total n=77</i>
	<i>Awebere n=27</i>	<i>Medejalela n=20</i>	<i>Tula n=30</i>	
Shortage of own land	96.3	90.0	93.3	93.5
Availability of extra cash	29.6	10.0	6.7	15.6
Availability of extra draught power	14.8	10.0	3.3	9.1
Availability of extra labor	3.7	0.0	10.0	5.2
To assist the land rights-holder	37.0	20.0	0.0	18.2
Other reasons (not specified)	0.0	5.0	13.3	6.5

\* percentages do not add up to 100 because of multiple responses.

Source: Survey results

One interesting outcome of this survey is that land rental transactions are made among people who know each other very well. More precisely, about 90% of the sample respondents reported that they rented land from their close relatives, friends and neighbours. This is possibly because of the ease at which arrangements are made (not written, often without witness) and their flexible nature. With respect to the location of the rented-in land the great majority of the respondents (88%) reported that the land they rented-in was located within their village (peasant association). The fact that 12% of the sample respondents rented land from other villages shows that rental transactions are not confined to the boundaries of the village land.

The rental agreements were reported to be of short duration. About 90% of the respondents who reported to have rented in land stated that their rental agreements were for three years or less; only 10% of the respondents indicated that their rental agreements were for longer than three years. All of the sample respondents reported that land rental transactions took the form of share-cropping with the commitment by both parties to share the benefits of the outputs and the share-renter to pay for all inputs. While the amount that the share-renters paid to the land rights-holders was on the average one-

third of the produce, the land rights-holders were responsible for the payment of land tax to the government.

The survey results reveal also that land was rented-out by some farmers who were disabled, had no sufficient labour and no oxen and lack working capital (Table 4). About 6% of the sample farmers reported that they rented-out an average of 0.46 hectares of their land. Among those households that rented-out their land, 73.7% and 26.3% were male-headed and female-headed, respectively. The great majority of the respondents (92%) stated that their rental agreements were for two years or less. The sample respondents who rented out land reported also that participated in rental transaction on average for a period of three and half years since the down fall of the military regime.

**Table 4:** Percentage distribution of respondents who rented-out land by reasons for renting out land \*

<i>Reasons for leasing out land</i>	<i>Peasant Association</i>			<i>Total n=19</i>
	<i>Awebere n=3</i>	<i>Medejalela n=9</i>	<i>Tula n=7</i>	
Lack of seed	33.3	11.1	28.6	21.1
Lack of cash	33.3	33.3	0.0	21.1
Lack of draught power	66.7	44.4	14.3	36.8
Labor shortage	100.0	77.8	85.7	84.2
Disability of the land rights-holder	0.0	33.3	0.0	15.8
Other reasons (not specified)	0.0	33.3	0.0	15.8

\* percentages do not add up to 100 because of multiple responses.

Source: Survey results

Another form of access to land in the study area is cultivating borrowed fields<sup>9</sup>. These fields are given by the land rights-holders to the users free of charge. The survey results show that only 6 respondents (about 2% of the total respondents) cultivated borrowed fields and the average size of the borrowed land was 0.35 ha. It is important to note that those who cultivated borrowed fields owned an average of 0.81 hectares of land whereas the remaining farmers owned an average of 1.1 hectares of land, implying that those who cultivated borrowed lands do so principally because of the small size of their holdings. While four of the six respondents who cultivated borrowed fields indicated that they got the land from their close relatives, the remaining two reported that they got it

<sup>9</sup> Borrowing is a temporary arrangement (often for one production season) of receiving the right to cultivate land. This arrangement is often made between people who are related through kinship. Borrowing involves very little material obligation of the borrower towards the lender. No money or presents are given and no labour contributions are expected in exchange. However, the borrower may give to the lender grain and other presents.



from people with whom they had long term and close relationships. All the respondents who cultivated borrowed land reported that the land rights-holders authorized them to use the land for one year and they did not have to pay anything in exchange. This result is in complete agreement with GAVIAN and EHUI (1999) who reported similar results for Arsi zone of the Oromia Regional State in Ethiopia.

Table 5 summarizes the responses to a pre-coded question on the most important factors, which affect agricultural production in the study area. The Table shows that the most important limiting factors, as perceived by the respondents, are related to availability of land and other inputs. For instance, the shortage of grazing land was cited as the most important problem affecting animal production in the study area. Similarly, the shortage of arable land was cited by about 82% of the sample respondents as a serious factor affecting agricultural production in the study area. In this connection, it is interesting to note that 62.5% and 37.5% of the sample respondents indicated that the size of their land holding was very small and just adequate, respectively.

Table 5 shows also that about 80% of the respondents cited weather variability (drought) as an important barrier to agricultural production. In fact, in the course of informal discussion with key informants it became clear that drought had become a structural problem that people had to live with in the study area. With respect to the frequency of drought occurrence, the key informants indicated that in the 1970s and 1980s drought occurred once in a decade but in recent years drought has struck the study area every 3 to 4 years. The situation can become even more problematic if farmers continue relying solely on rain fed agriculture as is the case now. It is also important to note that about 52% of the respondents cited the shortage or lack of working capital as an important barrier to agricultural production. The fact that individuals are unable to use land as collateral and are, therefore, unable to access credit makes this problem very crucial. The shortage of working capital wouldn't be a serious problem if households had the possibility to participate in non-farm activities that would enable them earn income and thereby ease their liquidity constraint. However, only 18% of the sample respondents reported earning income from non-farm activities.

Table 5 provides compelling evidence that peasant agriculture in the study area is beset with a host of economic, institutional and social challenges which need to be properly addressed to come to grips with the problem of food insecurity. This is precisely because the great majority of the sample respondents (71%) reported that they had not been producing enough amounts of food crops that could make them food self-sufficient year round. It is especially during the dry season that food shortage problem reaches a crisis point in the study area. The respondents indicated that, in alleviating their food deficit, their coping strategies (their way to persevere) included measures like: selling any cash crop (e.g. *Chat*) or animals to generate money to buy food with (40.2%); seeking credits in cash or kind from persons who are able and willing to extend them (20.5%); sending of able bodied male members of the family to nearby towns to engage in petty trade or to work as daily labourers to generate income (18.3%); and receiving food aid from humanitarian agencies (2.6%).

**Table 5:** Major Constraints to Agricultural Production as Perceived by the Respondents

\*

<i>Factors</i>	<i>Peasant Association</i>			<i>Total</i>
	<i>Awebere</i>	<i>Medejalela</i>	<i>Tula</i>	
	<i>% of respondents</i>	<i>% of respondents</i>	<i>% of respondents</i>	
Scarcity of grazing land	95.1	99.1	97.0	97.1
Land scarcity (arable land)	77.5	86.4	81.2	81.8
Weather variability (drought)	82.4	85.5	71.3	79.9
Lack of improved seeds	57.8	60.0	79.2	65.5
Lack of draught power	54.9	69.1	59.4	61.3
Lack of chemical inputs	57.8	51.8	73.3	60.7
Lack of working capital	57.8	60.9	35.6	51.8
Low product prices	56.9	42.7	48.5	49.2
Lack of advisory services (extension)	43.1	26.4	53.5	40.6
Lack of improved farm tools	38.2	50.0	24.8	38.0
Soil erosion (land degradation)	25.5	56.4	22.8	35.5
Shortage of labor during peak periods	41.2	11.8	49.5	33.5
Late availability of inputs (delay)	34.3	8.2	32.7	24.6
Lack of veterinary services	17.6	12.0	36.6	21.9
Crop pests and diseases	32.4	11.8	17.8	20.4
Storage problem	7.8	3.6	21.8	10.9
Lack of market outlet	7.8	11.8	9.9	9.9
Others (non- specified)	3.9	5.5	3.0	4.2

\* percentages do not add up to 100 because of multiple responses.

Source: Survey results

When requested to indicate the dominant observable trends of the farming systems of their area over the past ten years, almost all respondents (99.7%) pointed out that perennial crops such as *chat* and coffee have become more important (replacing annual crops) principally because they are relatively drought resistant and fetch higher income per unit area. Other important trends reported by the sample respondents include putting marginal areas under cultivation (74.6%), reduction in livestock population (55.3%) and shrinkage of communal grazing lands (21.2%). With regard to security of land ownership right, almost all of the respondents (99.4%) indicated that they felt

secure to use their farmland at least in their lifetime. This high percentage could be attributed to the fact that there was no land redistribution in the study area.

## 5 Conclusion

This paper examined farmers' access to cultivated land in three districts of Eastern Ethiopia. It is believed that this study, although limited both in its coverage and scope, provides information to all concerned in agricultural development so that they can make informed decisions. The historical review reveals that the issue of rural land ownership rights has been a politically sensitive topic throughout the country's modern history. The empirical results indicate also that shortage of arable land, scarcity of grazing land, recurrent droughts, lack of working capital, lack of advisory services, inadequacy of relevant technologies (improved seeds, chemicals, improved farm tools) were the most important barriers to agricultural production the study area.

The results of this study show also that state ownership has resulted in smaller and fragmented individual land holdings which, in turn, have led to the cultivation of marginal lands. Under the current situations of limited off-farm employment opportunities and population pressure, state ownership of land makes peasant agriculture simply a "refuge" for the growing rural population. In fact, the current state ownership of land does not provide the right incentives to enterprising farmers. Nor does it reflect a cohesive policy direction on the part of the government in that the government claims to be committed to build a free market economic system while maintaining state ownership of land.

In the light of these results it is imperative that policymakers pay utmost attention to the constraints that beset peasant agriculture. More precisely, the empirical results point to the fact that improved access to land is not a sufficient condition to improve households' productive capacity and their welfare. In fact, farmers also need access to complementary productive and institutional resources, including financing, advisory services, efficient marketing system, technology, and rural infrastructure if the potential benefits of improved access to land are to be achieved. The debate about land ownership rights (whether to maintain state ownership or embrace a system of privatization of rural lands) would be simply an exercise in futility if it is dissociated from the multitude of problems that farmers have to live with.

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## Determinants of Land Contracts and Efficiency in Ethiopia: The Case of Libokemkem District of Amhara Region

G. Ayele\*<sup>1</sup> and T. Mamo<sup>2</sup>

### Abstract

The land policy reform that took place in the 1990s in northern Ethiopia has resulted in various forms of land contracts and efficiency. As a policy measure, sale of land is officially prohibited while leasing and inheritance are allowed in one form or another. This paper attempts to assess the efficiency of the different forms of tenure arrangements emerging in Libokemkem district of the Amhara region, northern Ethiopia, and their implication for land tenure policies.

With the help of maximum likelihood estimates the effect of various factors on total operated fields was examined. The maximum likelihood result indicates that oxen ownership; family size, age, and total income determine the total cultivated land. It was also shown that choice of crops (tef and wheat) resulted in positive estimates indicating that crop types determine the land area operated. Choice of tenure arrangement on the other hand depends on livestock units, large family size and food shortages, and access to markets. This finding calls for a kind of intervention, which can support operation of informal land markets to be more efficient than the prevailing situation.

**Keywords:** land contracts, efficiency, land tenure policies, Ethiopia, Libokemkem

### 1 Introduction

There are different arguments regarding sharecropping and land tenure arrangements in productivity and efficiency. The efficiency of land lease market is a critical issue in many developing countries including Ethiopia. Land markets are obviously thin and inhibited by problems of asymmetric information and limited development of credit markets. The issue will be more important in Ethiopia, under a situation where land sales are officially prohibited but leasing and inheritance are allowed in one form or another. The government of Ethiopia has taken measures in land reform; however, the land still remains as a public property. The policy measures taken after 1991 have

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\* corresponding author

<sup>1</sup> Gezahegn Ayele, Debre Zeit Agricultural Research Center, P.O.Box, 32, Debre Zeit, Ethiopia.

<sup>2</sup> Dr. Tekalign Mamo, Winrock International, P.O. Box 2417, Addis Ababa, Ethiopia.

Current address: Ministry of Agriculture and Rural Development, P.O. Box 62347, Addis Ababa, Ethiopia

regional dimension and further implication on equity. Autonomous rights were given to regional administrations for internal land administration and policy implementation.

In Amhara National Regional State, the redistribution of land has taken place in 1997, deepening the reform process as an equity measure between males and females. Consequently, many women households have had access to land irrespective of size and quality. It is believed that the measures would show positive impacts on productivity and in poverty alleviation. Although land lease and inheritance are allowed, restrictions are imposed on the mechanisms of how these work.

However, there still appears to be land scarcity, due to population growth and declining productivity. Consequently people switch to different forms of land acquiring mechanisms. Leasing or renting of land, sharecropping, inheritance of land are some of the common forms of land arrangement currently operating in the area. It is against this background that this paper attempts to assess the efficiency of the different forms of tenure arrangements emerging in Ethiopia, particularly in the Amhara region and their implication for land tenure policies.

### **1.1 Empirical evidences and theoretical consideration**

Anecdotal empirical studies have indicated mixed impacts of forms of land tenure arrangement on productivity. JOHNSON (1950) and CHEUNG (1969) argued that if the tenants' work effort can be monitored without cost and enforced by the land lord, then resource allocation can be as efficient under sharecropping as under owner cultivation or fixed-rent tenancy. The majority of studies do not find significant inefficiency of share tenancy (OTSUKA and HAYAMI, 1988). The available literature on the effect of alternative land tenure contract is dominated by studies conducted in South and south east Asia, with little information from sub-Saharan Africa. Hence we do have very scanty information in sub-Saharan Africa particularly, in Ethiopia.

Although there is a kind of informal land market, no study has been conducted to verify the impact of the market on productivity. The informal land market or transaction in the study area has more of gender dimension. Although females have in principle equal rights to share land with males during redistribution of land, which took place in 1997 in Amhara region, however, most women are oxen-less, and have little or no capital compared with their male counterparts. This process has resulted in the informal transaction of land. Female farmers with abundant farmland often rent out or lease out their land for male farmers. Few male farmers also rent out their land for lack of sufficient working capital. The lease-out and lease-in or rent-in and rent-out of land takes different forms. It may take place on verbal agreement in some cases and in some other cases with written agreement.

The traditional institutions play an important role in this regard to fulfil the function of land transaction. In such case, for ease of analysis we classify the forms of tenure arrangement into those owned [PA (peasant association) allocated] and operated and those non-PA allocated (land importers) in the form of rent-in and sharecropped farm-

land. This study makes use of the data collected at household level and their plots in order to verify the impacts.

## 2 Methodology

### 2.1 Choice of the study area and its some characteristics

The study, which was conducted in June 2000/01 was part of a survey work aimed at formulating a food security enhancement project (WINROCK INTERNATIONAL ETHIOPIA, 2000). General information about the study area and its characteristic features are given in another report (MAMO and AYELE, 2003). Reconnaissance type of survey was conducted to rapidly investigate and visualize the resource endowments and institutional set up of the area under investigation. After examining the initial data set including the secondary data sources, survey was conducted on sampled households. Equidistant strata of households were constituted from which households were selected from sex and age proportions within the households. Inter and intra household composition was considered in setting the sample size. The proportion ( $N_i$ ) of households selected taking into consideration each *Limat tabia* (development center), depend on the number of male and female-headed households ( $n_i$ ) and standard deviation of major variables. In this regard a total of 150 farmers (94 male and 56) were selected from the peasant association for a detailed survey. The data collection procedure involved selecting and training enumerators and sample farmers. Some response and measurement errors were difficult to detect and correct, although efforts were made to minimize errors.

Farmers in study areas are mainly subsistence practicing mixed crop livestock system. Tef (*Eragrostis tef*) and wheat are the dominant crops. The villages are located in the high potential cereal producing areas with little access to markets. Consequently the use of purchased inputs such as fertilizer and improved seeds are less in the study area than in many parts of Ethiopia.

The average family size is close to 5 households. The variability is however, very high within the households. The average farm size also differs between female and male-headed households. The mean holdings in female-headed households are 0.809 ha as against 1.02 ha in male-headed households. Farm area can actually be classified as cultivated area (allocated for various crops), grazing area, forest, and unused area. The allocation of farmland to various crops depends upon the priority of crops in the household. Continuous subdivision and redistribution of the available land resulted in excessive fragmentation of landholdings and a decrease in the size of land. Some evidence in the study area indicates that land fragmentation has increased and is greater than the previous time (since 1992). On the other hand, landlessness has decreased because of land redistribution. The decrease in average land size holding, on the other hand, might be due to distribution and redistribution of land, which took place in the region; this resulted in various forms of tenure arrangement to acquire extra land, which is the subject to be discussed in this paper.



## 2.2 Method of data analysis

Econometric method has been employed to model the effect of land use, lease contract choice, use of labour, oxen and output. We have collected data on two major dependent variables cropland area operated, and choice of land contract forms (sharecropping + rent land), which could be affected by many factors. If transaction costs are to be monitored the role of each factors would be different. However, due to lack of sufficient database and the informal land marketing role of traditional institutions, we did not tend to evaluate the influence of transaction costs on efficiency.

The econometric model here specified with the use two ways of modelling:

1. Maximum likelihood estimation, assuming that  $u_i$  is independently and identically normally distributed across households and censored estimation. The model is employed here to estimate the effect of various factors on total operated fields for cereal production. Here the assumption is, the area operated includes the total cultivated land for crop production including those plots imported or transferred from other sources, i.e. sharecropping + rent-in land.
2. Multinomial probit model, employed to address the effect of the same variables as used in (1) on household imported/transferred plots. A fairly comprehensive choice of households for the land operated was modelled and estimated as one system of interrelated decisions (PENDER and FAFCHAMPS, 2001).

The two models were provided as follows:

$$\text{Cropland} = \beta_{cr} Z_i + \mu_i \quad (1)$$

$$\text{Contrchoic} = \alpha LY + \sigma_i \quad (2)$$

Where  $\beta_{cr}$  is the coefficient estimated,  $Z_i$  is a vector of observed variables affecting desired area operated and  $u_i$  is the unobserved error term in (1).

Choice of contract land (sharecropped + rent-in) as in equation (2) depends on other factors provided by vector Y and estimated coefficient of  $\alpha$  which also includes the exogenous variable of CROPLAND variable as independent variable. The choice variable indicated was between own land which is acquired through land distribution process from peasant association (PA) and that of the transferred or imported land (sharecropped + rent-in). The variables hypothesised to have effect on both cropland and choices of land contract are indicated in Table 1.

## 3 Results of the Study

According to the theory, area cultivated may be affected by the household's endowments of land, labour, capital, and other assets determining household income. The household's physical endowments are represented in the regression specification by the logarithms of land owned, household labour supply, value of fertilizer, and livestock owned. The physical endowments are represented in the regression specification, by the logarithms of land owned, logarithms of oxen number, logarithms of livestock owned and wheat area. Human capital endowments (potentially affecting farm productivity) were represented by age and level of education of the household head.

**Table 1:** Description of the explanatory independent variables Variable descriptions

<i>Variable descriptions</i>	<i>Variables</i>
Level of education in years	EDUCATIO
$\ln(\text{family size})$	LNFAMSIZ
$\ln(\text{land owned})$ in hectare	LNOWN
$\ln(\text{plots acquired through transfer rent in sharecropping})$	LNPLOTS
$\ln(\text{oxen owned})$	LNOXEN
$\ln(\text{livestock owned})$	LNTLU
$\ln(\text{age in years})$	LNAGE
DAP fertilizer used	TOTALDAP
Urea fertilizer used	TOTALURE
Distance from main market centre in minute	DISTANCE
Food shortage (Dummy = 1 if yes, =0 otherwise)	FOODSHOR
Total agriculture income earned	INCOMTOT
Total tef production in kg	TEFPRODU
Total wheat production in kg	WHTPROD
Hired labour in number	HIRELABR

The censored regression results are presented in Table 2. The maximum likelihood estimates support the effect of oxen ownership, family size, age, and total income earned from cultivated land and distance from main market centres on cropping land as shown in Table 2. Family sizes and oxen ownership have indicated a positive and yet a significant association with the ownership of land. The effect of livestock ownership, though has shown a positive coefficient, is no longer significant due to large standard error in the model. The model result further indicated that *tef* and wheat yield have resulted in positive close association in the maximum likelihood estimates, supporting the hypothesis that production of the two crops depends on land area operated.

Interestingly enough, higher oxen ownership significantly increases area operated in the model. It is also equally true that household endowments such as owned plots acquired through PAs, plots rented and sharecropped have a positive impact on land cultivated although not that strongly significant. Household family size and age of the farmer have also contributed positively and significantly to the effect on land cultivated and operated. More land was brought into cultivation as family size increases and age increases. Whether or not types of access to land were affected by various factors was modelled using a multinomial probit model. It is hypothesised that land tenure arrangement is a construct of specific tenancy contracts or tenure arrangements in a specific farming system (PENDER and FAFCHAMPS, 2001). In that case certain variables

**Table 2:** Determinants of ln (cultivated land under cereal) - Censored Regression

<i>Variables</i>	<i>Coeff.</i>	<i>Std.Err.</i>	<i>t-ratio</i>	<i>P-value</i>
EDUCATIO	0.0829	0.048	1.70818	0.0876***
LNFAMSIZ	0.203	0.055	3.6874	0.0002*
LKNOWN	0.219	0.062	3.3846	0.000*
LNPLOTS	0.083	0.050791	1.6372	0.1015
LNOXEN	0.0003	0.0002	2.7568	0.0058**
LNTLU	0.006	0.0001	0.4832	0.6289
LNAGE	0.1674	0.03314	4.96865	.006*
TOTALDAP	0.002	0.00010	0.19783	0.843
TOTALURE	0.0002	0.00013	1.93899	0.052***
DISTANCE	-0.0003	0.00008	-4.17385	0.0002**
FOODSHOR (Dummy =1 if yes, =0 otherwise)	-0.06351	0.052501	-1.20983	0.226
INCOMTOT	-0.0006	0.00003	-2.26476	0.0235**
TEFPRODU	0.0003	0.0006	6.73789	0.0001*
WHTPRODU	0.00023	0.00002	7.83858	0.0000*
HIRELABR	-0.06221	0.0617986	-1.00667	0.31409
Sigma	0.26357	0.0161063	16.3648	0.000002

\*, \*\* and \*\*\* are significant at 1%, 5% and 10% of significant level

were hypothesised to confirm to the expected sign of the model results. We used the same variables for explanatory variables as in the censored regression model in Table 2.

It is clear that many factors are operating and closely associated with both owned land and acquired land (sharecropping and renting). It is interesting to see that age of the farmer is closely and positively associated with own land and with share transfer (Table 2). This might be due to the fact that farmers at older age have less land to plough than at younger age. The extra land might have been transferred or given away to their children who can plough. It might be due to this effect that the variable age was positively associated with sharecropped/inherited farms whereas it was negatively and closely associated in own farms. Transferred plots or sharecropped plots are acquired mostly by young persons who are also transferred from older farmers in the community through various forms. Youngsters, particularly unmarried, ones are often landless and hence their major source of land could be acquired from older people or parents in the household. Married couples who are youngsters, they often acquired land from their

parents as gifts or even in some cases as sharecropped land. They cannot directly access land from the peasant association, because the distribution has already taken place.

Variables of food shortage, family sizes, and total livestock units have positive association with transferred farms. It might be possible that farms facing food shortages, larger family sizes and having larger number of livestock require additional land. Thus they acquired extra land through transfer of land (sharecropping/gift/rent) from those who have excess land. This picture clearly depicts the need for strategic move or adjustment and investment on land particularly in households with excess labour.

On the other hand, family size, food shortage, and oxen ownership were associated negatively with own land (PA-allocated land), although family size and oxen ownership are not significant in the model. The negative and significant association of food shortage with own land might be the result of more farmland being brought under cultivation, probably due to higher demand for food, which reduces the household food deficit. Distance from major market centres, in both cases, has resulted in a negative association. As most farms are located far away from market centres, the desire to choose farmland for cultivation by importing more land declines. The closer the farm land to the major market centres, the more the propensity will be to acquire additional plot of land. Although, it is negatively associated with own farm (PA-allocated) it did not turn out to be significant. It might be due to the even distribution of PA allocated farms to the owner operator than the sharecropped or rented-in plots. In any case, choice of the land markets depends on infrastructural development. This is indicative of the fact that any investment towards infrastructure is a key to development of land market, be it formal or informal market. *Tef* and wheat production is significantly and positively associated to own cultivated land. This might also be due to the high priority or value accorded to the crops in the diet of the family. Nevertheless, this trend is not similar to imported land for *tef* production. It seems that more priority is given for wheat production to increase household food security than *tef* production. Normally, the productivity of wheat per hectare of land is higher than that of *tef*, and this could also be the reason for the preferential selection of wheat over *tef* by farmers. Hence the choice of the farmland (owned or imported) depends on the type of crop produced for a household consumption.

#### **4 Conclusion and Implications**

After the redistribution of land in the Amhara region, land markets or exchange of land has taken different forms but mainly based on local institutions. In general, the redistribution of land has a profound effect on equity; some factors are emerging which tend to affect household level total operated farms for crop production. These are oxen ownership, family size, age of the farm households, type of crop produced (mainly *tef* and wheat), input use (inorganic fertilizer) and distances from major plots to market centres. Whether or not types of contract choices were associated with farm specific and human factors were investigated. It is essentially observed that land import for sharecropping and rent-in land for the goal of crop production, functions informally and efficiently.

**Table 3:** Determinants of tenure arrangement choice-Multinomial probit model Equation imported land (sharecropping+rent-in)

<i>Variables</i>	<i>Coeff.</i>	<i>Std.Err.</i>	<i>t-ratio</i>	<i>P-value</i>
LNOXEN	-0.00016	0.0005	-0.275	0.78298
LNTLU	-0.00031	0.0006	-0.376	0.70548
LNAGE	0.507824	0.1618	3.136	0.00136*
LNCULT	-0.00149	0.0013	-1.07	0.28177
LNFAMSIZ	-0.05468	0.3283	-0.166	0.86733
INCOMTOT	-0.00013	0.00016	-0.841	0.40093
FOODSHOR	0.204505	0.24622	0.8305	0.40622
DISTANCE	-0.00248	0.00037	-2.6597	0.050941***
TEFPRODU	0.0001232	0.00044	0.27623	0.782346
WHTPRODU	0.0003011	0.00015	1.88666	0.059209***
HIRELABR	-0.132982	0.33418	-0.3974	0.690686
<i>Equation (RHS) for own land</i>				
LNOXEN	0.0003	0.00096	0.03393	0.97206
LNTLU	-0.0004	0.00113	-0.2945	0.76855
LNAGE	0.46364	0.26282	1.7641	0.07771***
LNCULT	-0.0007	0.0049	-0.0755	0.93979
LNFAMSIZ	0.4186	0.4694	0.89165	0.37257
INCOMTOT	0.000121	0.0002	0.55197	0.58094
FOODSHOR	-1.24674	0.03783	-2.6520	0.081438***
DISTANCE	-0.00041	0.0005	-0.7955	0.42616
TEFPRODU	2.000345	0.0003	2.91709	0.035091***
WHTPRODU	2.0093	0.0002	2.01779	0.067125***
HIRELABR	0.2507	0.5270	0.47575	0.63447

\* , \*\* and \*\*\* are significant at 1%, 5% and 10% of significant level

The traditional institutions are playing an important role in the informal market for land to function efficiently. But there are constraints, which affect, both choice of own land (PA-allocated) and imported land (non-PA land). The existence of imperfect markets for oxen, and the associated distance from markets compels us to believe that efforts to improve the functioning of the markets are more likely to improve agricultural efficiency than the land market itself. It may be worthwhile not to totally intervene

with the operation of the informal land markets, but rather to improve the institutional framework under which it operates more efficiently.

### **Acknowledgement**

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## Crop Performance and Yield of Groundnut, Sesame and Roselle in an Agroforestry Cropping System with *Acacia senegal* in North Kordofan (Sudan)

K. E. M. Fadl<sup>1</sup> and J. Gebauer<sup>2</sup> \*

### Abstract

Crop performance and yield of groundnut (*Arachis hypogea*), sesame (*Sesamum indicum*) and roselle (*Hibiscus sabdariffa*) were investigated in an intercropping system with *Acacia senegal* and compared with sole cropping. The study was conducted in North Kordofan (Sudan) on loamy sand. Experimental design was a randomized complete block with split plots.

Crop performance and crop yield of groundnut, sesame and roselle were significantly ( $p < 0.05$ ) reduced in the intercropping system compared to sole cropping. However, yield reduction in groundnut (53%) was much higher than in sesame (6%) and roselle (14%).

The reduction in yield of the intercropping plots could be due to the high tree density, which results in water and light competition between the trees and the agricultural crops.

**Keywords:** *Arachis hypogea*, 'Hashab', *Hibiscus sabdariffa*, parkland cropping, *Sesamum indicum*, soil conservation, Sudan, yield reduction

### 1 Introduction

Greater Kordofan lies within the Savanna zone of Central Sudan. Most of the rural people depend on production of their own agricultural crops. The traditional rain-fed agriculture involves a bush-fallow system (shifting cultivation) on the sandy soil (HUSSEIN, 1983). However, in recent years, successive droughts, desertification and the decline in soil fertility mean that there is a need for a new concept for rational use of resources for sustainable agricultural production, such as agroforestry systems.

The concept of rational use of natural resources for sustainable production has captured international attention. In this respect, the significant role of agroforestry has been emphasized as a rational farming practice, particularly in fragile ecosystems similar to Kordofan (NOEL *et al.*, 1990; FADL, 1999).

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<sup>1</sup> B.Sc. M.Sc. Kamal E. M. Fadl, Agricultural Research Corporation, El Obeid Research Station, P.O. Box 429, El Obeid, Sudan

<sup>2</sup> Dr. Jens Gebauer, Agricultural Research Corporation, Gezira Research Station, P.O. Box 126, Wad Medani, Sudan, E-mail: jens.gebauer@rz.hu-berlin.de (corresponding address: Dept. of Fruit Science, Humboldt-University Berlin, Albrecht-Thaer-Weg 3, 14195 Berlin, Germany)

\* corresponding author



*Acacia senegal* (L., Willd.), locally known as 'Hashab', of the family Leguminosae is an important multipurpose tree species for the Sudan and other tropical countries. It is the main producer of 'Gum Arabic' and also provides firewood, building material and fodder. Trees such as *A. senegal* play a considerable environmental role in combating desert encroachment and minimizing soil erosion in North Kordofan (NAS, 1986). Among the main cash crops in the North Kordofan area are groundnut, sesame and roselle. Groundnut and sesame are used for producing oil. The fleshy calyx of the roselle is used for local drinks and is exported to different countries (BASHIR, 2001). The purpose of the field experiment was to determine the effects of *A. senegal* on the growth performance and yield of groundnut (*Arachis hypogea* var. Sodari), sesame (*Sesamum indicum* var. Harihri) and roselle (*Hibiscus sabdariffa* var. Shaloft Elnaga) in an agroforestry system.

## 2 Material and Methods

### 2.1 Study area

El Demokeya forest reserve is located 30 km east of El Obeid town (latitude 13° 11' N, longitude 30° 12' E). The forest covers more than 3150 ha and is naturally dominated by *Acacia senegal*. The soil is classified as Entisol, according to the USDA Soil Survey and locally known as 'Goz'. The soil texture is loamy sand, where the sand fraction amounts to more than 90%. The concentrations of organic matter, nitrogen and phosphorus are very low, less than one percent. The annual rainfall in this area ranges between 280 and 450 mm in the months from July to September. The mean relative humidity is 34% and varies between 14% in the dry season and 60% in the wet season. Evaporation is 15.5 mm and increases to 20.0 mm in hot summer months. The mean annual minimum and maximum temperatures range between 20°C and 35°C, respectively.

### 2.2 Experimental design

The study was conducted in a 15 year-old parkland plantation of *Acacia senegal* within the El Demokeya forest reserve. The trees had an average height of 247 cm and an average crown width of 205 cm.

The experimental design was a randomized complete block with split plots and four replications. Each block was divided into six plots: three plots represented the intercropping, while the other three represented the sole cropping (control). Plot size was 20 × 20m. Intercropping plots had an average of 20 trees per plot. Initially, the experimental sites were manually cleared of undesirable vegetation and fenced as necessary. Seeds of groundnut, sesame and roselle were sown on 15<sup>th</sup> of July 1999. Plant holes were manually dug with a hoe at the spacing 60 × 20 cm, 50 × 30 cm and 50 × 50 cm for groundnut, sesame and roselle, respectively. The seed rate for groundnut and roselle was 2 seeds per hole and for sesame 3 seeds per hole. The spacing and seed rate were applied according to the standard practice of El Obeid Agricultural Research Station. Two weedings were done at both sites after 14 and 30 days after sowing.

The crops were harvested at physiological maturity during November (groundnut, sesame) and December (roselle) in the same year. Plant height, number of leaves and

capsules, and crop yield were measured after harvesting the plants.

Data were analysed by using the *MSTAT-C statistical package* (version 2.10) developed by Michigan State University. For the parameters showing significant differences, the means were compared by the least significant differences (LSD at 0.05).

### 3 Results

Results of plant height are shown in Table 1. Analyses of variance indicate significant differences ( $p < 0.05$ ) between the two cropping systems in the sesame and roselle crop. In the groundnut crop the plant height was not significantly reduced in the intercropping system.

Table 2 shows the number of leaves per plant in the intercropping and sole cropping system of the tree crops. Numbers of leaves were significantly reduced in the intercropping system for all crop species. The highest reduction was recorded for sesame.

Numbers of capsules in the intercropping and sole cropping of groundnut, sesame and roselle are shown in Table 3. In all crops there were lower numbers of capsules per plant in the intercropping. However, the difference for roselle was not significant. The

**Table 1:** Plant height of groundnut, sesame and roselle as affected by cropping system (cm).

<i>crop</i>	<i>intercropping</i>	<i>sole cropping</i>
groundnut	17.2 <sup>a</sup>	18.4 <sup>a</sup>
sesame	44.8 <sup>a</sup>	58.2 <sup>b</sup>
roselle	63.7 <sup>a</sup>	67.1 <sup>b</sup>

Means within a row followed by different letters are significantly different ( $p < 0.05$ ) according to LSD test.

**Table 2:** Number of leaves of groundnut, sesame and roselle as affected by cropping system.

<i>crop</i>	<i>intercropping</i>	<i>sole cropping</i>
groundnut	22.7 <sup>a</sup>	29.3 <sup>b</sup>
sesame	26.0 <sup>a</sup>	51.0 <sup>b</sup>
roselle	40.7 <sup>a</sup>	57.0 <sup>b</sup>

Means within a row followed by different letters are significantly different ( $p < 0.05$ ) according to LSD test.

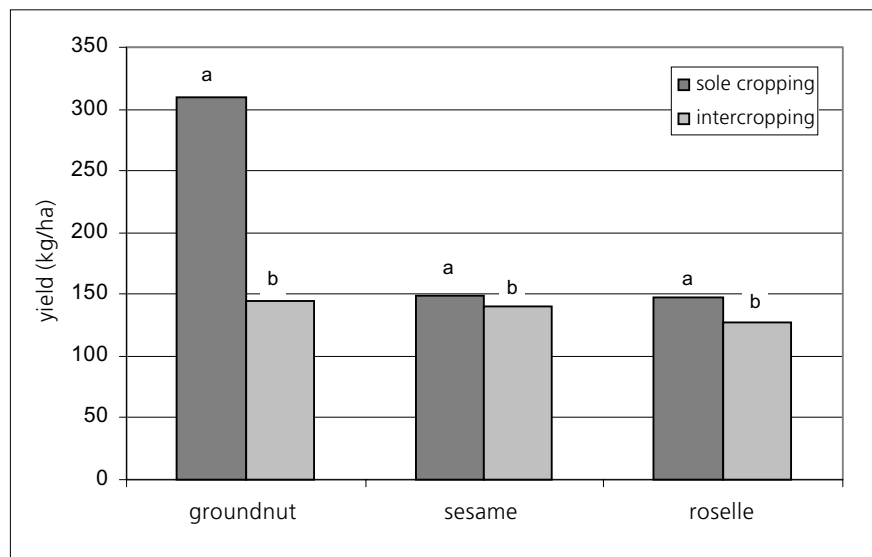
**Table 3:** Number of capsules of groundnut, sesame and roselle as affected by cropping system.

<i>crop</i>	<i>intercropping</i>	<i>sole cropping</i>
groundnut	10.3 <sup>a</sup>	14.0 <sup>b</sup>
sesame	12.3 <sup>a</sup>	14.0 <sup>b</sup>
roselle	26.3 <sup>a</sup>	26.7 <sup>b</sup>

Means within a row followed by different letters are significantly different ( $p < 0.05$ ) according to LSD test.

comparative yields of groundnut, sesame and roselle in the intercropping plots and sole crop plots are shown in Figure 1. The difference in yield was highest in the groundnut crop. Intercropping reduces the yield by 53% from 309.9 kg/ha to 144.5 kg/ha. The yield reduction in sesame and roselle was only 6% and 14%, respectively. However, the differences were still significant.

**Figure 1:** Yield of groundnut, sesame and roselle as affected by cropping system. Means with different letters are significantly different ( $p < 0.05$ ) according to LSD test.



## 4 Discussion

Trees are considered to have a positive influence on the soil physical properties and the soil nutrient content. Investigations in a plantation of *A. senegal* on sandy soils in Kordofan have recently shown that the soil was much richer in organic matter and in the major nutrient elements (AHMED and NIMER, 2002). The higher N level in the soil is often attributed to the ability to fix atmospheric nitrogen in symbiosis with rihzobium in root nodules of *Acacia* spp. (ZHANG *et al.*, 1992). Nitrogen input levels are particularly important, since many dry soils are nitrogen deficient (JAMES and JURINAK, 1978; NOEL *et al.*, 1990).

Nevertheless, the growth and yield of each crop species were depressed when combined with *A. senegal* because of interspecific competition, which in some instances may become detrimental (RUSSEL, 1955). In the growing season 1999 the annual rainfall was exceptionally low with less than 300 mm. Competition for water results in adverse effects of trees on intercrops under moisture stress conditions (ICRISAT, 1987).

The water deficiency effect was especially high in the groundnut crop resulting in the highest reduction in growth and yield. During the experiment it was already observed that the groundnut plants suffered from water deficiency in the intercropping plots (wilt-ing).

This can be attributed to the shallow root system of the groundnuts. Generally sandy soils are characterized by a high infiltration rate. After heavy rain the upper soil layer often dries within a few hours. The high competition between the roots of the crop and the tree in the upper soil layer probably results in the high yield reduction in the groundnut crop. Sesame and roselle are characterised by a tap root system, which allows them to reach water in deeper soil layers.

Shading can also be seen as a factor which can lead to a reduction in crop performance and yield in the intercropping systems (NEWMAN *et al.*, 1998; RAO *et al.*, 1998). Groundnuts are a rather short crop reaching a maximum height of 20 cm above soil level on the sandy soils in Kordofan. The negative effect of tree shading was strongest in the groundnut crop, because the low height of the crop means that it has very limited possibilities to grow out of the shade. In contrast to groundnuts, sesame and roselle have much higher vertical growth (Table 1) and therefore have a much higher ability to reach available light. The high tree density also results in a greater cultivable area being sacrificed to the trees, which leads to a reduced yield per ha.

However, agroforestry systems including *A. senegal* provide a good household income from 'Gum Arabic' production (US\$ 346 per ha and season) which can easily compensate for the yield losses. Also, *A. senegal* in Central Sudan serves a major role in soil conservation, preventing erosion restoring fertility and providing fuel wood and fodder as a multipurpose tree (BUNDERSON *et al.*, 1990).

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## Utilisation of *Mucuna* Beans (*Mucuna pruriens* (L.) DC ssp. *deeringianum* (Bart) Hanelt) to Feed Growing Broilers

L. W. Trejo<sup>\*1</sup>, R. Santos<sup>1</sup>, E. Hau<sup>1</sup>, L. Olivera<sup>2</sup>, S. Anderson<sup>3</sup> and R. Belmar<sup>1</sup>

### Abstract

Performance of broilers fed on diets containing mucuna beans (MB) (*Mucuna pruriens* (L.) DC ssp. *deeringianum* (Bart) Hanelt) with different treatments were studied in three experiments. First experiment: three sorghum diets using 0 and 280g/kg of MB raw or soaked were evaluated. Second experiment: three sorghum diets using 0 and 280g/kg of MB raw or boiled were evaluated. Third experiment: six maize diets: maize only, three diets containing 280g/kg of MB raw, soaked or boiled, one containing soybean and a balanced diet (control) were evaluated. Experiment one: the birds fed on the 0g MB/kg showed a higher live weight gain (LWG) and a lower feed:gain ratio (FG) ( $p < 0.01$ ) than birds fed on the MB diets. There were no differences for any of the variables studied between the birds fed on the MB diets. Experiment two: the birds fed on the 0g MB/kg performed better ( $p < 0.01$ ) than birds fed on the MB diets. However, birds fed on the boiled MB diet had a higher LWG and a lower FG ( $p < 0.01$ ) than birds fed on the raw and soaked MB diet. Experiment three: the birds fed on the control diet obtained a higher LWG ( $p < 0.01$ ) than birds fed on the remainder treatments. The birds fed on the raw MB diet had a lower FG ( $p < 0.01$ ) than birds on the remainder treatments. However, birds fed on the boiled MB had a higher LWG and feed intake than birds fed on raw and soaked MB diets and only maize diet ( $p < 0.01$ ), but, lower ( $p < 0.01$ ) in comparison to birds fed on the soybean diet. The birds on the raw and soaked MB diets performed worst ( $p < 0.01$ ), even in comparison to birds fed on only maize ( $p < 0.01$ ). The results from these experiments indicated that inclusion of 280g MB/kg in the diet affected adversely the poultry performance. However, utilisation of MB boiled improved the broilers performance compared to birds fed on the raw and soaked MB diets.

**Keywords:** broilers, mucuna, performance, raw, soaked, boiled, *Mucuna pruriens* ssp. *deeringianum*

### 1 Introduction

The most popular agricultural system practiced by indigenous people in southeast of Mexico and many countries in Latino America is the agroecology system called "milpa".

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\* corresponding author

<sup>1</sup> Facultad de Medicina Veterinaria y Zootecnia-Universidad Autónoma de Yucatán, Apartado Postal 4-116 Itzimna, C.P. 97000, Mérida, Yucatán México, Fax: (99) 42-32-05, Email: wtlizama@tunku.uady.mx

<sup>2</sup> Centro de Investigaciones y Estudios Avanzados del Instituto Politécnico Nacional

<sup>3</sup> Imperial College at Wye-University of London

This is a small scale production system where agriculture practices and livestock production are harmonized. In this system some animals such as poultry (chicken, turkey and ducks) and pigs are kept in the backyard. The animals are fed with products and by-products from the agriculture such as maize and forages (REJÓN *et al.*, 1996). The animals are used as a source of protein and to save money that could easily be tapped into when cash is needed (REJÓN *et al.*, 1996; WIEMAN and LEAL, 1998). In such production system some legumes are used, such as the mucuna (*Mucuna pruriens* (L.) DC ssp. *deeringianum* (Bart) Hanelt).

The mucuna bean (MB) is used as a green manure in the milpa to improve soil fertility and to increase the maize yield. However, the beans from mucuna some times do not have any practical use in the production system (ANDERSON *et al.*, 2001). Recently, some efforts to use the MB in animal feeding have been done. TREJO *et al.* (1999b) and TREJO and BELMAR (2000) reported a better acceptance of mucuna by chicks than other legumes. As many legume seeds, MB have antinutritional factors (ANFs) that reduces its utilisation in animal feeding. Protease inhibitors and phenols for example L-dopa has been found in MB. Some treatments to reduce the ANFs in MB have been used, such as heating (autoclaving and dry roasted) and soaking. Some of these treatments have had success to improve the performance of chickens fed MB (OLABORO *et al.*, 1991; TREJO *et al.*, 1999a; DEL CARMEN *et al.*, 1999). But no study is available to reflect the interaction of the MB treatment and the improvement of diet quality of small scale farming systems. The aim of this study was therefore to evaluate the response of growing broilers fed on high and low quality diets containing MB raw, soaked or boiled, with respect to feed intake, weight gain and feed conversion.

## **2 Materials and Methods**

The experiments were carried out at the Facultad de Medicina Veterinaria y Zootecnia in Yucatan, Mexico. This site has a tropical climate with an annual average temperature of 27.7°C and an annual precipitation of 800 mm (GOBIERNO DEL ESTADO DE YUCATÁN, 1983).

### **2.1 Animals**

Ninety-six male broilers were used in experiment one. Sixty broilers (30 male and 30 females) were used in experiment two and one hundred and ninety two broilers (96 females and 96 males) were used in experiment three. All broilers were from a commercial line Hubbard

### **2.2 General management**

The broilers were from one day hatch when arrived. At arrival the chicken were kept in brooder rings during fifteen days. The first five days the chickens were kept in a heater and received soluble vitamins and minerals in the water. At age seven days there were vaccinated against Newcastle. During this period they were fed with a commercial diet (22% crude protein and 13 MJ ME/ kg). At the age of fifteen days the chickens were weighed and assigned to their respective treatments.

During the experiments the chickens were caged in pairs. In the second and third experiments a female and a male were accommodate in each cage. The cages were 40 by 40 centimetres. Each cage had a feeder and a drinker.

### 2.3 Treatments to mucuna beans

Raw: The MB were milled with a sieve of 3 millimetres and then included in the diets.

Soaked: The MB were broken in five to eight pieces in a meal with a sieve of half an inch. Then, the MB were soaked in water during 24 hours in a water-MB ratio of 1:2 (kg/kg) After that, the MB were dried in an oven at 60°C. Finally, the MB were milled with a sieve of 3 millimetres.

Boiled: The MB were broken as in soaked treatment and then boiled during thirty minutes at 100°C in a water-MB ratio of 1:2 (kg/kg). Then, the MB were dried in an oven at 60°C. afterwards, the MB were milled with a sieve of 3 millimetres.

### 2.4 Experimental diets

Experiment one: Three sorghum-based diets were used. Two diets included 280 g/kg of MB raw or soaked and a diet based in sorghum and soyabean meal (control) (table 1). All the diets were balanced to the same concentrations of energy and protein according to NATIONAL RESEARCH COUNCIL (1994).

Experiment two: Three isonitrogenous and isoenergetic sorghum-based diets were used, two diets included 280 g/kg of MB raw or boiled and one with out MB an based in soybean meal and sorghum as control diet (table 2). The diets were balanced according to NATIONAL RESEARCH COUNCIL (1994).

Experiment three: This experiment was carried out with maize only as the control, reflecting the feeding conditions for poultry in rural backyards in the southeast of Mexico, where maize usually represents the main or only component of the diet REJÓN *et al.* (1996). The diets were: maize only, three diets included 280 g/kg of MB raw, soaked or boiled and one included soybean meal (maize + SBM) this with the objective to match the same amounts of nutrients of the diets with MB. There was also, a balanced diet based in maize and soybean meal according to NATIONAL RESEARCH COUNCIL (1994) as a control diet (table 3). These diets with MB varied in energy, nitrogen and aminoacid concentration, compared to the diet only maize and balanced diet.

### 2.5 Experimental procedure

Food intake was calculated as the difference between feed offered and feed refusal by cage, from which a value for the mean food intake per chicken per day was derived. The live weight gain was calculated on an individual chicken basis using the initial weight and final weight per cage, from which individual chicken weight was estimated. Using average daily food intake and live weight gain per chicken , feed:gain ratio was calculated. The duration of the each experiment was fifteen days.



**Table 1:** Diets used in experiment one

<i>Ingredients (g/kg)</i>	<i>Diets</i>		
	<i>Control</i>	<i>Raw MB</i>	<i>Soaked MB</i>
Soybean meal	338	215	215
Sorghum	595	418	418
Soybean oil	30	50	50
Mucuna beans	0	280	280
Methionine	1	2	2
Calcium	14	13	3
Dicalcium phosphate*	15	17	17
Salt	3	3	3
Mineral premix <sup>†</sup>	1	1	1
Vitamin premix <sup>‡</sup>	1	1	1
Salinomycin	1	1	1
Flavomycin premix <sup>§</sup>	1	1	1
<i>Composition (%)</i>			
Crude Protein	20.0	20.0	20.0
ME (MJ/kg)	13.0	13.0	13.0
Crude Fibre	3.6	4.6	5.0
Lysine	1.1	1.1	1.1
Methionine+cystine	0.7	0.7	0.7
Calcium	0.9	1.0	1.0
Total phosphorus	0.7	0.6	0.6

\* Concentration : *P* 21%, *Ca* 18%.

<sup>†</sup> Concentration of minerals/kg of premix: *Mg* 15g, *Mn* 20g, *Fe* 18g, *Cu* 4g, *Zn* 60g, *Se* 0.042g, *I* 0.005g, *Co* 0.060g, *Na* 9g.

<sup>‡</sup> Concentration of vitamins/kg of premix: Vit. A: 1,800,000 UI, Vit. D<sub>3</sub>: 640,000 UI, Vit. E: 400 UI, Vit. K: 160 mg, riboflavine: 1400mg, pantothenic acid: 600mg, niacine: 8000mg, piridoxine: 200mg, choline: 120,000mg, Vit. B<sub>12</sub> 4.4mg.

<sup>§</sup> Concentration of Flavomycin: 4%.

## 2.6 Experimental design and statistical analysis

A randomised design was used in the three experiments. There were sixteen repetitions per treatment in experiment one and three, and ten repetitions per treatment in experiment two. The experimental unit was the cage. The means of the different treatments in each experiment were compared to using the Duncan test. Data obtained was analysed using ANOVA procedure of SAS INSTITUTE (1990).

**Table 2:** Diets used in experiment one

<i>Ingredients (g/kg)</i>	<i>Diets</i>		
	<i>Control</i>	<i>Raw MB</i>	<i>Boiled MB</i>
Soybean meal	345	216	216
Sorghum	560	391	391
Soybean oil	58	74	74
Mucuna beans	0	280	280
Methionine	1	2	2
Calcium	14	12	12
Dicalcium phosphate*	15	18	18
Salt	3	3	3
Mineral premix <sup>†</sup>	1	1	1
Vitamin premix <sup>‡</sup>	1	1	1
Salinomycin	1	1	1
Flavomycin premix <sup>§</sup>	1	1	1
<i>Composition (%)</i>			
Crude protein	20.0	20.0	20.0
ME (MJ/kg)	13.6	13.6	13.6
Crude fibre	4.0	4.0	4.0
Lysine 1.1	1.1	1.1	
Methionine + Cystine	0.7	0.7	0.7
Calcium	0.9	0.9	0.9
Total phosphorus	0.7	0.7	0.7

\* Concentration : P 21%, Ca 18%.

† Concentration of minerals/kg of premix: Mg 15g, Mn 20g, Fe 18g, Cu 4g, Zn 60g, Se 0.042g, I 0.005g, Co 0.060g, Na 9g.

‡ Concentration of vitamins/kg of premix: Vit. A: 1,800,000 UI, Vit. D<sub>3</sub>: 640,000 UI, Vit. E: 400 UI, Vit. K: 160 mg, riboflavine: 1400mg, pantothenic acid: 600mg, niacine: 8000mg, piridoxine: 200mg, choline: 120,000mg, Vit. B<sub>12</sub> 4.4mg.

§ Concentration of Flavomycin: 4%.

### 3 Results

#### 3.1 Experiment one

As is shown in table 4, the feed intake in this experiment was similar between the treatments ( $p > 0.01$ ). However, live weight gain was higher in birds fed on the control diet ( $p < 0.01$ ) than in birds fed on diets with MB. Inversely, feed:gain ratio was lower in birds fed on the control diet ( $p < 0.01$ ) in comparison to birds fed on diets with MB (table 4).

**Table 3:** Diets used in experiment one

Ingredients (g/kg)	Diets					balanced
	Maize	Maize + raw MB	Maize + soaked MB	Maize + boiled MB	Maize + soybean meal	
Soybean meal	0	0	0	0	132	338
Maize	992	712	712	712	858	598
Mucuna beans	0	280	280	280	0	0
Soybean oil	0	0	0	0	0	46
Methionine	0	0	0	0	0	1
Calcium	1	1	1	1	1	3
Dicalcium phosphate*	0	0	0	0	0	7
Salt	3	3	3	3	3	3
Mineral premix <sup>†</sup>	1	1	1	1	1	1
Vitamin premix <sup>‡</sup>	1	1	1	1	1	1
Salinomycin	1	1	1	1	1	1
Flavomycin premix <sup>§</sup>	1	1	1	1	1	1
<i>Composition (%)</i>						
Crude protein	8.8	13.3	13.3	13.3	13.4	20.0
ME (MJ/kg)	13.1	13.0	13.0	13.0	13.5	13.6
Crude fibre	2.6	3.2	3.2	3.2	3.1	3.9
Lysine	0.3	0.6	0.6	0.6	0.6	1.1
Methionine+cystine	0.4	0.4	0.4	0.4	0.5	0.7
Calcium	0.3	0.3	0.3	0.3	0.3	0.9
Total phosphorus	0.2	0.2	0.2	0.2	0.3	0.7
* Concentration : P 21%, Ca 18%.						
<sup>†</sup> Concentration of minerals/kg of premix: Mg 15g, Mn 20g, Fe 18g, Cu 4g, Zn 60g, Se 0.042g, I 0.005g, Co 0.060g, Na 9g.						
<sup>‡</sup> Concentration of vitamins/kg of premix: Vit. A: 1,800,000 UI, Vit. D <sub>3</sub> : 640,000 UI, Vit. E: 400 UI, Vit. K: 160 mg, riboflavine: 1400mg, pantothenic acid: 600mg, niacine: 8000mg, piridoxine: 200mg, choline: 120,000mg, Vit. B <sub>12</sub> 4.4mg.						
<sup>§</sup> Concentration of Flavomycin: 4%.						

### 3.2 Experiment two

In this experiment the feed intake was higher in birds fed on the control diet ( $p < 0.01$ ) than in birds fed on diets with MB. Similarly, live weight gain was higher in birds fed on the control diet ( $p < 0.01$ ) in comparison to birds fed on diets with MB. Also, live weight gain was higher in chickens fed on boiled MB than birds fed on raw MB. Feed gain ratio was lower in chickens fed on the control diet ( $p < 0.01$ ) in comparison to chickens fed on diets with MB. However, feed gain ratio was lower in chickens fed on boiled MB ( $p < 0.01$ ) than chickens fed on raw MB (table 5).

**Table 4:** Performance of growing broilers fed on raw and soaked mucuna bean diets in experiment one.

	<i>Treatments</i> <sup>1</sup>			<i>SE ±</i>
	<i>Control</i>	<i>Raw MB</i>	<i>Soaked MB</i>	
Initial weight (g)	421.5	420.8	419.5	4.77
Live weight gain (g /day)	59.4 <sup>a</sup>	42.9 <sup>b</sup>	44.5 <sup>b</sup>	1.31
Feed intake (g/day)	105.7	105.3	105.8	2.50
Feed:gain ratio	1.79 <sup>a</sup>	2.47 <sup>b</sup>	2.40 <sup>b</sup>	0.04

<sup>1</sup> values with different letters differ statistically significant ( $p < 0.01$ )

**Table 5:** Performance of growing broilers fed on raw and boiled mucuna bean diets in experiment two.

	<i>Treatments</i> <sup>1</sup>			<i>SE ±</i>
	<i>Control</i>	<i>Raw MB</i>	<i>Boiled MB</i>	
Initial weight (g)	319.0	319.2	317.8	8.58
Live weight gain (g/day)	51.6 <sup>a</sup>	19.3 <sup>b</sup>	26.8 <sup>c</sup>	1.52
Feed intake (g/day)	79.7 <sup>a</sup>	51.3 <sup>b</sup>	52.8 <sup>b</sup>	2.42
Feed:gain ratio	1.55 <sup>a</sup>	2.81 <sup>b</sup>	1.99 <sup>c</sup>	0.11

<sup>1</sup> values with different letters differ statistically significant ( $p < 0.01$ )

### 3.3 Experiment three

The highest weight gain was observed in broilers fed on the balanced diet ( $p < 0.01$ ) followed by broilers fed on the maize + soybean meal (SBM) and maize + boiled MB, respectively. The lower live weight gain was observed in chickens fed on the raw and soaked MB diets ( $p < 0.01$ ) in comparison to the birds in the remainder diets, even in comparison to the birds fed only maize (table 6). A higher feed intake was found in birds fed on the maize + SBM diet ( $p < 0.01$ ), followed by birds fed on the control diet ( $p < 0.01$ ) than in birds fed on the boiled MB diet ( $p < 0.01$ ). However, bird fed on the boiled MB diet had a higher feed intake than birds fed on the raw and soaked MB diets. Birds fed on the raw and soaked MB diets had a lower feed intake ( $p < 0.01$ ) in comparison to birds fed only maize (table 6).

The feed:gain ratio was extremely high in birds fed on the maize + raw MB diet than in the remainder diets ( $p < 0.01$ ). The soaked and boiled treatment of MB improved

the feed:gain ratio in comparison to birds fed on the raw MB diets ( $p < 0.01$ ). The feed:gain ratio were similar between birds fed on only maize, boiled MB and maize + SBM diets ( $P \leq 0.01$ ). The lower feed gain ratio was observed in birds fed on the control diet (table 6).

**Table 6:** Performance of growing broilers fed on maize based diets with MB in experiment three.

	Treatments <sup>1</sup>					Balanced	SE $\pm$
	Maize	Maize + raw MB	Maize + soaked MB	Maize + boiled MB	Maize + SBM		
Initial weight (g)	409.2	408.4	409.7	408.8	409.4	408.6	7.92
Live weight gain (g/day)	14.2 <sup>d</sup>	0.7 <sup>e</sup>	2.0 <sup>e</sup>	22.5 <sup>c</sup>	46.2 <sup>b</sup>	51.0 <sup>a</sup>	1.52
Feed intake (g/day)	66.5 <sup>d</sup>	40.9 <sup>f</sup>	50.1 <sup>e</sup>	83.7 <sup>c</sup>	110.2 <sup>a</sup>	97.2 <sup>b</sup>	2.79
Feed:gain ratio	4.8 <sup>b</sup>	67.5 <sup>a</sup>	17.5 <sup>b</sup>	3.8 <sup>b</sup>	2.4 <sup>b</sup>	1.9 <sup>b</sup>	4.8

<sup>1</sup> values with different letters differ statistically significant ( $p < 0.01$ )

#### 4 Discussion

The soaked treatment of MB in experiment one did not improved the productive performance in the broilers. As a result, the birds fed on the soaked MB diet performed similar to broilers fed on the raw MB diet. In contrast by using high inclusion levels (of up to 48%) of MB TREJO *et al.* (1999a) found a better performance in chicks using soaked MB. These researchers reported that soaking treatment of MB is effective in reducing L-dopa. According to BUDAVARI (1989) L-dopa is very soluble in water and oxidize easily in contact with air.

In the second experiment the live weight gain, feed intake and feed:gain ratio of broilers fed on the boiled MB diet improved in comparison to broilers fed on the raw MB diet. These observations are in agreement with results where broilers were fed with MB treated by heat (OLABORO *et al.*, 1991; DEL CARMEN *et al.*, 1999). The results suggest that some ANFs in MB are susceptible to be eliminated by thermic treatments. According to VAN DER POEL A. F. B. (1989) the thermic treatments are very effective to remove some ANFs such as the protease inhibitors. However, the boiling treatment of MB was not so efficient to improve the performance of the broilers, in comparison to broilers fed on the maize + SBM diet.

In the experiment three the broilers fed on the raw and soaked MB diets performed worse than the broilers fed on the remainder diets, even in comparison to broilers fed on the only maize diet. In this case the soaked treatment also showed its inefficiency to remove ANFs in MB. This results indicated that some ANFs in MB are not soluble in water. Nevertheless, the boiling treatment of MB improved the broilers live weight gain

and feed:gain ratio compared to broilers fed on the raw MB diets and the only maize diet. The performance of birds on boiled MB in experiment three was similar to results obtained in experiment two. The food intake of birds fed on boiled MB was greatest than the only maize diet but the total maize consumed was 10% less than the only maize diet.

Finally, the better performance of broilers fed on the control diet than broilers fed on the remainder diets was due to a well balance of aminoacids.

The results obtained in this research work pointed out that inclusion of MB in the diet reduced the performance of growing broilers in comparison to balanced diets. The soaked treatment of MB was not effective enough to improve the performance of growing broilers in comparison to broilers fed on the raw MB diet even in comparison to birds fed only maize, but boiling treatment of MB increased the live weight gain, feed intake and reduced feed conversion in comparison to the raw and soaked MB and only maize diets. The boiling of MB could increase the productive performance of broilers fed only with maize based diets in peasant systems. This results lead to the conclusion that the main antinutritional factors in MB are thermo labile.

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## Socio-economic and Technical Characteristics of Backyard Animal Husbandry in Two Rural Communities of Yucatan, Mexico

R. Santos Ricalde<sup>\*1</sup>, C. E. Hau<sup>1</sup>, R. Belmar Casso<sup>1</sup>, I. Armendariz Yañez<sup>1</sup>, R. Cetina Góngora<sup>1</sup>, L. Sarmiento Franco<sup>1</sup> and J. Segura Correa<sup>1</sup>

### Abstract

This research work was conducted in order to assess the socio-economic and technical aspects of backyard animal rearing in two communities of Yucatán, México. One hundred and thirty nine families were interviewed in Sudzal ( $C_1$ ) and 117 families in San Jose Tzal ( $C_2$ ). A structured questionnaire was used to interview the families on technical and socio-economic aspects. Using this information the technical level of animal husbandry and a index of socio-economic status of the families involved in backyard animal rearing in both communities were determined. In  $C_1$  46.8% of the interviewed families reared animals in their backyard in comparison to 70.9% in  $C_2$ . Main animal species kept in the backyard were chickens ( $C_1= 92.3\%$  and  $C_2= 88.0$ ), turkeys ( $C_1= 63.1\%$  and  $C_2= 55.4\%$ ) and pigs ( $C_1= 38.5\%$  and  $C_2= 5.7\%$  in  $C_1$  and  $C_2$  respectively). In  $C_2$  100% of pigs kept in the backyard were of the commercial type. Technical level in animal production was significantly higher ( $P < 0.0001$ ) in  $C_2$  than in  $C_1$ , because utilisation of commercial diets was higher in  $C_2$  ( $P < 0.001$ ) than in  $C_1$ . The families of  $C_2$  had a higher socio-economic level ( $P < 0.002$ ) than families from  $C_1$ , because families of  $C_2$  have houses built with lasting materials ( $P < 0.0001$ ) and the occupation of the head of the family was associated with higher income (merchants or employees) ( $P < 0.0001$ ). The correlation coefficients between socio-economic status and technical level in backyard animal production showed that 84% of the technical level was explained by the socio-economic status. It can be concluded that socio-economic status has a high influence on backyard animal production characteristics. The socio-economic status determine the number of animals kept and the technical level in animal rearing.

**Keywords:** backyard animal rearing, socio-economic status, technical level, Yucatan, Mexico

### 1 Introduction

Animal rearing is a common activity in backyards of rural communities of Mexico and other Latin-American countries (FLORES *et al.*, 1988). This animal production system includes mainly chickens, turkeys and pigs, which are an important source of protein

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\* corresponding author, Ronald Santos Ricalde, email: rsantos@tunku.uady.mx.

<sup>1</sup> Departamento de Nutrición Animal, Facultad de Medicina Veterinaria y Zootecnia. Universidad Autónoma de Yucatán, Apartado postal 4-116 Itzimna, Mérida, Yucatán, México.



for the rural families. Some animal species such as pigs are seemed as “pig bank” (BERDUGO and FRANCO, 1990). Animals are fed feedstuffs and by-products from the traditional agricultural system called “Milpa”. In Yucatan, México the Milpa is a small agricultural system in which several plant species are cultivated simultaneously and in harmony with the environment. The products from agriculture are used to feed the family, but, any extra amount as well as the by-products are normally used to feed animals (GONGORA *et al.*, 1986; ORTEGA *et al.*, 1993).

The backyard animal production has begun to undergo transformations due to the influence of external factors such as low availability of land for cropping; low productivity of the traditional agriculture system, which encourages people to migrate; and also because animal rearing is a low input-output system, which has no chance to compete with the industrialized systems (REJÓN *et al.*, 1996; RODRÍGUEZ *et al.*, 1996).

Technical aspects of the backyard animal rearing of rural communities have been transformed also by external factors, such as introduction of commercial breeds of animals and the utilization of commercial diets that have begun to be used to feed animals (REJÓN and SEGURA, 1997).

The objective of this research was to asses the socio-economic and technical aspects of backyard animal rearing in two communities of Yucatan, Mexico.

## 2 Materials and Methods

This research work was conducted in Sudzal and San Jose Tzal, two rural communities of Yucatan, Mexico. Sudzal is located in the eastern region of Yucatan, at 70 km from Merida, whereas San Jose Tzal is located in the southern area of Yucatan, at 20 km from Merida. Both communities were visited between May and July of 2002. The climate of the region is warm (average temperature ranging 21 to 33°C during the year). There is a rainy season between June and October, with an annual rainfall between 1000 and 1200mm (DUCH, 1988).

The families included in this study were those agreeing to be interviewed. One hundred and thirty nine families were interviewed in Sudzal (C<sub>1</sub>) and 117 families in San Jose Tzal (C<sub>2</sub>). A structured questionnaire was used to interview the families regarding aspects of backyard animal rearing and their household.

Information about socio-economic aspects, backyard animal keeping and agriculture activities was obtained also from those families.

Information on animal species, breeds reared and feedstuff used to feeding animals was also obtained. The technical level of animal husbandry was estimated using information on type of feeders, species supplied shelters, utilisation of commercial diets and utilisation of commercial breeds of animals. The following formulae were used to estimate the technical level of backyard animal rearing.

$$TF = \frac{NAC}{NAB} * RV$$

$$TAB = \frac{NCB}{NAB} * RV$$

$$TFS = \frac{NF + NS}{NAB} * RV$$

$$TTL = TF + TAB + TFS$$

Where:

TTL = Total technical level.

TF = Technical feeding system level.

NAC = Number of animal species fed commercial diets.

TAB = Technical level in animal breed used.

NCB = Number of species from commercial breeds.

TFS = Technical level of use of feeders and shelters.

NF = Number of species supplied feeders.

NS = Number of species supplied shelter.

NAB = Number of animal species in the backyard.

RV = Relative value (AQUINO *et al.*, 2003).

Only two species were considered for those calculations (poultry and pigs). Poultry included chickens and turkeys because of similar management for those species.

The relative value assigned to each technical component was 0.56 for feeding system, 0.25 for animal species from commercial breeds used and 0.19 for feeders and shelters utilization. The relative values were assigned according to AQUINO *et al.* (2003), who reported that those values represent the importance given to the role of each component by the rural families.

Socio-economic features of the families involved in backyard animal rearing such as, occupation of the head of the family, years attending to school, household characteristics (i.e. building materials), and electrical and drinking water services in the household were recorded for evaluation.

A index of socio-economic status was calculated using the information recorded about the socio-economic aspects, according to the following formulae:

$$SEI = YAS + HC + S + LO$$

Where:

SEI = Socio-economic index

YAS = Years that the head of family attended to school

HC = Household characteristics

S = House services

LO = Labour occupation of the head of the family

The socio-economic components used to calculate the SEI had a similar specific weight in the formulae. The number of years that the head of the family (HF) attended to school was considered for YAS determination. The number of years that the HF attended to school ranged from zero when HF did not attend school to 17 when HF coursed six years of primary school, three years of secondary school, three years of preparatory school and five years of professional studies. HC was estimated considering the following classification: 1) rustic households built with non lasting materials such as palm leaves and wood; 2) semi rustic household built with a combination of non lasting materials and lasting materials; and 3) households built with lasting materials. Services such as electricity and drinking water were taken into account for S determination. A value of one was assigned to each house service. The maximum value was two when both services were present in the house or zero if none of the services were present.

The occupation of the head of the family was classified as: 1) agriculture worker mainly; 2) retired and 3) employee or merchant. In relation to agriculture activities, the families were asked about staple food species cultivated in the Milpa.

The data obtained were analysed as percentage and medians. Technical level and socio-economic characteristics in both communities were compared and analysed statistically using Krustal-Wallis test.

### 3 Results

In  $C_1$  46.8% of the families interviewed reared animals in their backyard in comparison to 70.9% of the families in  $C_2$ . The main species kept in the backyard in both communities were chickens, turkeys and pigs. Similar proportion of families kept chickens (92.3% and 88.0% in  $C_1$  and  $C_2$ , respectively) and turkeys (63.1% and 55.4% in  $C_1$  and  $C_2$ , respectively) in both communities. However, a higher number of families kept pigs in  $C_1$  than in  $C_2$  (38.5% and 15.7%, respectively).

A similar number of chickens, turkeys and pigs were observed in both communities. However, the data showed that more animals are kept by family in  $C_2$  than in  $C_1$  (Table 1). Families in  $C_2$  kept twice the number of turkeys and pigs in the backyard than families in  $C_1$ . A relevant observation was associated to the trend of families from  $C_2$  to keep commercial breeds of pigs. In  $C_2$  100% of pigs kept in the backyard were of the commercial type (Table 1).

Families in  $C_2$  utilized a higher proportion of commercial diets to feed their animals (Table 2). In both communities the families tended to use more commercial diets to feed pigs. In  $C_2$  100% of families used commercial diets to feed their pigs. The utilization of commercial diets to feed pigs in  $C_2$  could be associated with the utilization of commercial breed of pigs. In contrast, a higher proportion of families in  $C_1$  used wild plants Such as *Leucaena leucocephala* and *Brossimun alicastrum* mainly, and kitchen wastes to feed pigs than in  $C_2$ . In  $C_2$  a higher proportion of families used "Tortilla" to feed poultry than families in  $C_1$ . Tortilla is a manufactured product made from maize devoted mainly for human consumption, bought in a tortilla supply store. On the other

**Table 1:** Number and distribution by species and breed of animals kept in the backyards of two communities in Yucatan, Mexico.

	<i>Communities</i>					
	<i>Sudzal</i>			<i>San Jose Tzal</i>		
	<i>Chicken</i>	<i>Turkey</i>	<i>Pig</i>	<i>Chicken</i>	<i>Turkey</i>	<i>Pig</i>
Total	865	305	118	828	320	98
Median/family	8	2	1.5	10	4	3
SD ±	16.7	8.2	4.5	9.4	14.4	10.5
<i>Breed</i>						
Creole (%)	100.0	100.0	84.0	98.6	97.8	100.0
Commercial (%)	0.0	0.0	16.0	1.4	2.2	0.0

**Table 2:** Feedstuffs, feeders and shelters used to rear animals in the backyard of two communities in Yucatan, Mexico.

	<i>Communities</i>			
	<i>Sudzal</i>		<i>San Jose Tzal</i>	
	<i>Poultry</i>	<i>Pig</i>	<i>Poultry</i>	<i>Pig</i>
Maize (%)	70.0	76.0	53.4	0.0
Tortilla (%)	45.0	48.0	67.1	0.0
Local plants (%)	15.0	48.0	5.5	0.0
Kitchen waste (%)	15.0	60.0	8.2	0.0
Commercial diets (%)	30.0	76.0	74.0	100.0
<i>Supply of:</i>				
Feeder	35.0	68.0	26.0	100.0
Shelter	43.3	60.0	31.5	100.0

hand, a higher proportion of families in C<sub>1</sub> used maize instead of tortilla and commercial diets to feed their animals, in comparison to families in C<sub>2</sub>.

A larger proportion of families used wild plants, kitchen wastes and commercial diets to feed pigs than poultry in C<sub>1</sub> (Table 2). Also, in both communities, a higher proportion of families use feeders and shelters to rear pigs than poultry. These observations could be associated to the use of pigs as “pig banks”. The families would care more for pigs and give them feedstuffs with a higher nutritional value, than poultry, because households can convert pigs into money when cash is needed for any family emergency.

Technical level in animal production was significantly higher ( $P < 0.0001$ ) in  $C_2$  than in  $C_1$ , because utilisation of commercial diets was higher in  $C_2$  ( $P < 0.001$ ) than in  $C_1$  (Table 3).

**Table 3:** Technical level in different aspects related to backyard animal production in two communities of Yucatan, Mexico.

Use of	Communities		SE	Probability Level
	Sudzal	San Jose Tzal		
Commercial diets	0.0	0.45	0.05	$P < 0.0001$
Commercial breeds	0.0	0.0	0.14	$P < 0.06$
Shelter and feeders	0.15	0.15	0.26	$P < 0.09$
Total	0.23	0.45	0.32	$P < 0.001$

The correlation coefficients between the socio-economic index and the technical level in backyard animal production showed that 84% of the technical level was explained by the socio-economic index (Table 4). Also, that table shows that utilisation of commercial breeds was closely associated with utilisation of commercial diets, feeders and shelters.

The families of  $C_2$  had a higher index of socio-economic status ( $P < 0.002$ ) than families from  $C_1$  (Table 5). This is because families of  $C_2$  have houses built with lasting materials ( $P < 0.0001$ ) and the occupation of the head of the family was associated with higher income (merchants or employee) ( $P < 0.0001$ ).

A significantly higher proportion of families make Milpa in  $C_1$  ( $P < 0.0001$ ) in comparison to  $C_2$  (Table 5). This result was also associated with type of occupation by the head of the family. In  $C_2$  86% of the head of the families were merchants or employees, while in  $C_1$  50% of the head of the families worked in their own Milpas (small scale farmers).

The main crops cultivated in the Milpa were: Maize (95.3% and 88.9% for  $C_1$  and  $C_2$ , respectively), squash (53.5% and 50% for  $C_1$  and  $C_2$ , respectively), local species of beans such as *Vigna unguiculata* and *Phaseolus vulgaris* (41.9% and 27.8% for  $C_1$  and  $C_2$ , respectively) and other crops such as melon, watermelon, cassava and cucumber (20.9% and 16.7% for  $C_1$  and  $C_2$ , respectively).

#### 4 Discussion

The lower proportion of families that rear animals in  $C_1$  in comparison to  $C_2$  could be associated with a better socio-economic status of the families in  $C_2$ . Socio-economic status of families played also an important role on the number of animals kept in the backyard. As a result, a higher proportion of turkeys and pigs were kept in the backyards of  $C_2$  as compared to  $C_1$ . Major availability of economic resources allowed keeping more animals and using commercial diets. According to REJÓN and SEGURA (1997) rearing turkeys and pigs in Yucatan has been associated with utilization of commercial diets.

**Table 4:** Correlation coefficients of socio-economic and technical variables obtained in two communities of Yucatan.

	<i>TTL</i>	<i>SEL</i>	<i>TF</i>	<i>TFS</i>	<i>TAB</i>
TTL	1.0000	0.8395	0.0101	0.0080	0.0134
SEI	0.8395	1.0000	- 0.0118	- 0.0104	- 0.0133
TF	0.0101	- 0.0118	1.0000	1.0000	0.9998
TFS	0.0080	- 0.0104	1.0000	1.000	0.9997
TB	0.0134	- 0.0133	0.9998	0.9997	1.0000

TTL= Total technical level

SEI= Socio-economic indexl

TF= Technical level in the feeding system

TFS= Technical level in the use of feeders and shelters

TB= Technical level in animal breeds used

**Table 5:** Socio-economic characteristics of families surveyed in two communities of Yucatan, Mexico.

<i>Item (Median)</i>	<i>Communities</i>			<i>SE</i>	<i>Probability Level</i>
	<i>Sudzal</i>	<i>San Jose Tzal</i>			
<i>Head of the family features</i>					
Years attending to school	3	6		3.37	P > 0.05
Labour occupation*	2	3		8.84	P < 0.0001
<i>Household characteristics</i>					
Household built materials <sup>†</sup>	2	3		0.71	P < 0.0001
Household Services <sup>‡</sup>	2	2		0.18	P > 0.05
Socio-economic index	11	12		3.78	P < 0.002

\* Rural farmer = 1; Retired = 2; Employee or Merchant = 3

<sup>†</sup> Lasting materials = 1; Combination of lasting and no lasting materials = 2; No lasting materials = 3

<sup>‡</sup> Electricity or potable water = 1; Both, electricity and potable water = 2

The preference to rear chickens in both communities agrees with observations made in other studies (BERDUGO, 1987; BARREDO *et al.*, 1991; AQUINO *et al.*, 2003). According to these authors the rural families prefer to keep chickens in the backyard because of their lower maintenance cost and because they are easier to rear in comparison to pigs.

The higher index of socio-economic status of the families in C<sub>2</sub> as opposed to the families of C<sub>1</sub> is well justified by the proximity to Merida, the capital city of Yucatan. A higher proportion of people from C<sub>2</sub> work in Merida as employee or merchants. Those people are commuters who going to work in Merida.

The results obtained in the correlation analysis showed that a higher index of socio-economic status was related to a higher technical level in animal management in the backyard. This higher technical level was associated with utilisation of commercial diets and commercial animal breeds. These results agree with findings reported for other animal production systems; as the socio-economic status of the farmer increase so does the technical level of the animal production system (NUNCIO *et al.*, 2001).

The results obtained in this study showed that as the animals tended to become from Creole breeds the families tended to use more locally available resources such as products from the milpa, local plants and kitchen wastes. Inversely, as the animals came from commercial breeds the families tended to use commercial diets for feeding proposes. This effect was observed mainly in pig rearing.

The correlation analysis showed also, a narrow relationship between animal species and utilisation of commercial diets, feeders and shelters. As mentioned earlier the families prefer to invest economic resources to rear pigs because such animals can be sold when cash is needed (RICHARDS and LEYVA, 1985). In C<sub>2</sub> where particularly rearing of commercial breeds of pigs, is an additional activity carried out to allow an extra income.

Utilisation of maize and wild plants instead of tortillas and commercial diets to feed the animals in C<sub>1</sub> could be related to a major number of families involved in agricultural activities and the lower availability of economic resources. Conversely, in C<sub>2</sub> the lower trend to make Milpa and availability of economic resources allow a major dependence from tortillas and commercial diets (REJÓN and SEGURA, 1997).

It can be concluded that socio-economic status has a high influence on backyard animal production characteristics, it determines the number of animals kept and the technical level in animal rearing. The socio-economic status of the family was determined primarily by the employment opportunities of the household.

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## Efectos Agrobiológicos de Coberturas Verdes en el Cultivo de la Pitahaya (*Hylocereus undatus* Britton & Rose) en Nicaragua.

A. López Silva<sup>1</sup>, J. Pohlen<sup>2\*</sup> and D. Salazar Centeno<sup>1</sup>

### Resumen

El experimento fue realizado en Masaya - Tipitapa durante dos años, con la finalidad de determinar el efecto de diferentes coberturas verdes sobre la disponibilidad de materia orgánica, la biomasa, macronutrientes (*N,P,K*) en el suelo, la incidencia de plagas agrícolas, el crecimiento y rendimiento de la pitahaya, y estimar el equivalente del uso de la tierra. Los tratamientos incluyeron las coberturas verdes: *Mucuna pruriens*, *Cajanus cajan*, *Canavalia ensiformis*, *Vigna unguiculata*, *Dolichos lablab* y el manejo tradicional (sin cobertura), y el análisis del comportamiento de cuatro clones (Orejona, Lisa, Cebra y San Ignacio). Los tratamientos con *M. pruriens*, *C. cajan* y *C. ensiformis* produjeron más biomasa y aumentaron los contenidos de materia orgánica y *NPK* en el suelo. En ambos ciclos el clon más productivo y más resistente a plagas y enfermedades fue el Orejona con 2942 y 2547 kg ha<sup>-1</sup>. Se obtuvieron incrementos en el número de frutos por hectárea y en el rendimiento al asociar pitahaya con *D. lablab*, *C. cajan*, *M. pruriens* y *V. unguiculata*. El uso equivalente de la tierra fue mayor en coberturas verdes que en el manejo tradicional.

**Palabras claves:** *Hylocereus undatus*, cobertura verde, materia orgánica, macronutrientes, crecimiento, rendimiento, uso equivalente de tierra

### 1 Introducción

En Nicaragua, el cultivo de la pitahaya (*Hylocereus undatus* Britton & Rose) tiene gran importancia ya que ofrece buenas perspectivas para pequeños y medianos productores, dado que tiene mucha demanda nacional e internacional y puede generar divisas (SALAZAR y POHLAN, 1999; PIETRI, 1992). Desde 1994 este cultivo comienza a tomar importancia como un cultivo no tradicional de gran potencial de exportación contándose en la actualidad con 700 ha, lo cual la ubica en el primer lugar como productor de pitahaya roja a nivel Centroamericano (APPEN, 1997). La mayoría de las superficies cultivadas está en manos de pequeños y medianos productores, quienes utilizan métodos tradicionales de manejo del cultivo con suelos abiertos, conllevando esto a una disminución progresiva de la fertilidad del suelo, eliminación de toda la vegetación, dejando

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<sup>1</sup> A. López Silva, Universidad Nacional Agraria Managua, Nicaragua, Managua, Carretera Norte km. 13,5

<sup>2</sup> Prof. Dr. Jürgen Pohlen, ECOSUR, El Colegio de la Frontera Sur, Apdo. Postal 36, 30700 Tapachula, Chiapas, México

\* corresponding author

al suelo expuesto a la erosión eólica e hídrica, así como a un elevado proceso de evaporación de la humedad del suelo, limitando así los rendimientos de sus cosechas, y la obtención de frutos de mejor calidad, que no les permite ser competitivos en el mercado internacional. Es importante para que se lleve a cabo un buen manejo agronómico del cultivo, en las áreas ya establecidas y seguir ampliando la explotación del mismo, resolver problemas muy urgentes de manejo del sistema, manejo de coberturas y arvenses, fertilización, índole fitosanitario, y manejo postcosecha, que influyen negativamente en los rendimientos (INTA, 1996). De esta manera surge la necesidad de evaluar diferentes coberturas verdes en el cultivo de pitahaya, ya que existe muy poca información sobre la influencia de éstos sobre la fertilidad del suelo, manejo de arvenses, plagas, y enfermedades que permita hacer un análisis más integral de los factores de producción, para desarrollar alternativas apropiadas para los pequeños y medianos productores (POHLAN *et al.*, 1997), a quienes deben ir dirigidas las tecnologías a generar, ya que el 95% de la producción de Nicaragua se encuentra en manos de estos productores.

## 2 Materiales y Métodos

El experimento se estableció el 01 de Agosto de 1997 y finalizó el 27 de Febrero de 1999, en la Finca Frutas Tropicales; localizada en el Km. 38 de la carretera Masaya - Tipitapa. El área esta ubicada a 12° 13' Latitud Norte y 86° 04' Longitud Oeste. La finca se encuentra a una altura sobre el nivel del mar de 65m. La precipitación anual oscila entre 800-900 mm, la temperatura promedio es de 26°C y la humedad relativa media anual es de 75%. El suelo es franco arcilloso, ligeramente ácido y con un porcentaje de materia orgánica medio. Según USDA/SCS (1992) este suelo se clasifica como un Típico Handosol, Serie Nindirí.

El diseño experimental usado fue un bloque completo al azar, con seis tratamientos y tres repeticiones, con un área total de 3.600m<sup>2</sup>. El área de cada parcela experimental fue de 200m<sup>2</sup>, y la de la parcela útil 72m<sup>2</sup>. Cada parcela experimental estaba conformada por 25 plantas, para un total de 450 plantas en todo el ensayo. En cada parcela útil se analizó nueve plantas. Los diferentes clones evaluados fueron: Orejona, Lisa, Cebra y San Ignacio.

Tratamiento A: Sistemas de coberturas

- a1 *Mucuna pruriens* (L.) DC, Terciopelo, siembra de 39.1 kg ha<sup>-1</sup> (solamente 1° ciclo)
- a2 *Cajanus cajan* (L.) Millsp., Gandul, siembra de 46.9 kg ha<sup>-1</sup>
- a3 *Canavalia ensiformis* (L.) DC, Canavalia, siembra de 62.5 kg ha<sup>-1</sup>
- a4 *Vigna unguiculata* (L.) Walp., Caupí, siembra de 46.9 kg ha<sup>-1</sup>
- a5 *Dolichos lablab* (L.) Sweet., Caballero, siembra de 46.9 kg ha<sup>-1</sup>
- a6 Manejo tradicional, suelo temporalmente desnudo por manejo manual.

La plantación de pitahaya tenía dos años de establecida al momento de iniciar el ensayo, con distancias de siembra de 2 m entre planta y 4 m entre calle. Las labores culturales realizadas antes de sembrar las coberturas verdes se iniciaron con una limpia con azadón y machete. Una semana después se preparó el terreno con una labranza mínima para proceder a la siembra, la cual fue de forma manual. El corte de los abonos verdes

se realizó cuando finalizaron el ciclo biológico cada una de las especies. Fertilizantes minerales solamente fueron aplicados en el tratamiento a6 (manejo tradicional). Por un ataque de *Atta* spp. en la segunda siembra de *Mucuna pruriens*, se tuvo que eliminar este tratamiento de los análisis para la cosecha del ciclo 1998-99.

#### *Variables evaluadas:*

- Materia orgánica: Para determinar el aporte de materia orgánica de los abonos verdes se realizaron cuatro muestreos de suelo, uno antes de establecer el experimento para determinar la cantidad de materia orgánica disponible que presentaba el suelo
- Biomasa: Materia seca (g por m<sup>2</sup>) de arvenses y especies de abono verde al final del ciclo biológico de cada abono verde
- Nitrógeno: *N* disponible
- Fósforo: *P* disponible
- Potasio: *K* disponible
- Pitahaya: –Brotación vegetativa  
–Número y peso de frutos (g), diámetro polar y ecuatorial (cm)  
–Rendimiento (kg ha<sup>-1</sup>)

Las muestras de suelo fueron analizadas en el laboratorio de Suelos y Aguas de la Universidad Nacional Agraria. El análisis para las variables de arvenses (biomasa) fue descriptivo a través de gráficos con los valores promedios. Las variables de pitahaya se sometieron a un análisis de varianza y prueba de rango múltiple de Tukey con un alfa del 5%. El programa estadístico utilizado fue el Sistema Estadístico Americano (S.A.S).

### **3 Resultados y Discusión**

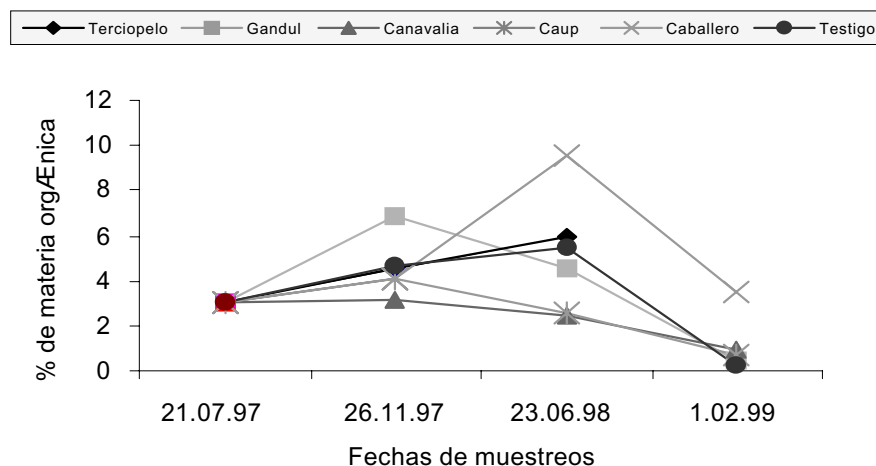
Para mantener la fertilidad e suelo a un nivel adecuado de producción es preciso que se repongan los elementos nutritivos que se pierden debido a la extracción de la cosecha, lavado del suelo, volatilización, entre otros. Una de las maneras de hacer esta reposición es de forma natural mediante la aportación de restos de vegetales y la fijación biológica (FUENTES YAQUES, 1994). Bajo esta óptica, la introducción de abonos verdes en agroecosistemas tropicales mejora la fertilidad del suelo, funcionando como fuente de nutrientes a través de su aporte de materia orgánica (BINDER, 1997).

#### **3.1 Materia orgánica**

El porcentaje de materia orgánica disponible en el suelo antes de establecer los abonos verdes fue de 3.01% (figura 1). En el segundo muestreo realizado, los contenidos de materia orgánica se incrementaron en todos los tratamientos. Los valores oscilaron entre 4.1 y 6.82 %. En el tercer muestreo la materia orgánica mas alta se midió en los tratamientos con *D. lablab*, *M. pruriens* y en el manejo tradicional con 9.54, 5.92 y 5.49%. Con esto se comprueba que los diferentes abonos verdes aportaron cantidades de materia orgánica en dependencia de su ciclo vegetativo y el tipo de follaje. En el último muestreo los porcentajes de materia orgánica disminuyeron drásticamente, lo que

se atribuye a efectos del Huracán Mitch, que provocó el lavado de la materia orgánica en el suelo.

**Figura 1:** Contenido de materia orgánica disponible en el suelo de los diferentes tratamientos.

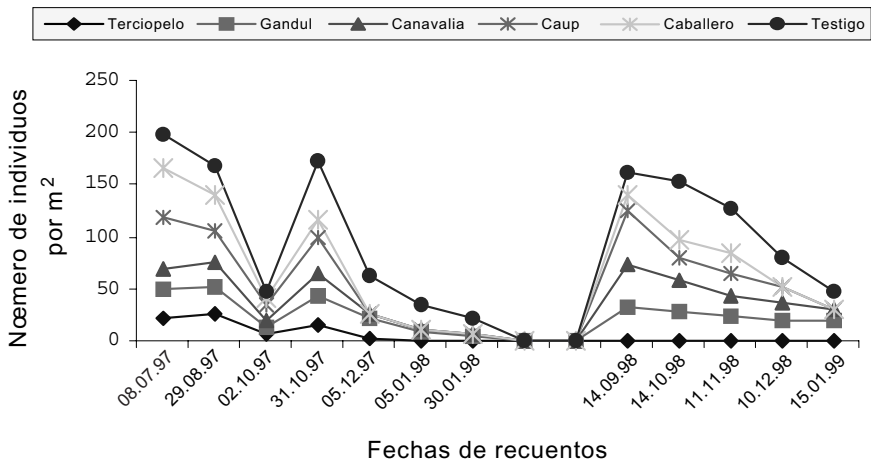


### 3.2 Abundancia, biomasa de arvenses y biomasa de especies de cobertura verde

En los años 1997-1999, los asociados con *M. pruriens*, *C. cajan* y *C. ensiformis*, redujeron mas eficiente la abundancia de arvenses, debido a su ciclo biológico y cobertura más prolongada y al excelente desarrollo de su área foliar (figura 2). El tratamiento con manejo tradicional presentó siempre la mayor abundancia. Esto demuestra que el uso de coberturas verdes es una práctica con grandes ventajas en el manejo de arvenses. Principalmente es recomendable *C. ensiformis*, que es una leguminosa que se adapta bien a condiciones de déficit hídrico durante la época seca en el trópico.

Los asociados que disminuyeron más eficiente la biomasa de las arvenses, fueron *M .pruriens*, *C. cajan*, *D. lablab* y *C. ensiformis*. Solamente en el asocio con *V. unguiculata* alcanzaron las arvenses una biomasa alta (tabla 1), debido al corto ciclo biológico de esta leguminosa y su menor cobertura, lo cual permitió una mayor abundancia de arvenses al momento de su madurez fisiológica. En el tratamiento con manejo tradicional, no obstante de varias limpiezas mecánicas, las especies de arvenses monocotiledóneas y dicotiledóneas acumularon la mayor biomasa. Esto es debido a que las arvenses tienen aquí una área descubierta, lo cual permite mayor actividad fotosintética, favoreciendo su crecimiento y desarrollo (EISZNER *et al.*, 1996). Resultados similares obtuvieron (BOLAÑOS y LOPEZ, 1996). Se puede afirmar, que el uso de coberturas verdes en asocio con pitahaya, es una práctica ventajosa y sostenible para el control de éstas. lo que se reflejaría en un incremento de los rendimientos y en una reducción de los costos de producción en pitahaya.

**Figura 2:** Efecto de los diferentes coberturas verdes y el manejo tradicional sobre la abundancia de las arvenses en el cultivo de la pitahaya.



La biomasa de coberturas verdes, mantenido verde o seca en el campo, implica evitar la tradicional quema de rastrojos, evitando indirectamente la pérdida de materia orgánica y nutrientes, así mismo como obstaculizar la desaparición de la flora y la fauna benéfica. En ambos ciclos agrícolas, la producción de biomasa de *C. cajan* y *C. ensiformis*, fue mayor, cuyos valores oscilaron entre 7000 y 7185 kg ha<sup>-1</sup>, lo que demuestra que éstas especies de leguminosas se adaptan bien a las condiciones agroclimáticas de la zona de estudio (tabla 1). La producción de biomasa de *V. unguiculata* y *D. lablab* fue similar en ambos ciclos agrícolas y osciló entre 3934.6 y 5212.3 kg ha<sup>-1</sup>. Es importante destacar que la biomasa generada por *M. pruriens*, en 1997, fue muy similar a la producida por *C. cajan* y *C. ensiformis*.

### 3.3 Nitrógeno

Antes de establecer las coberturas verdes en asocio con pitahaya, el porcentaje de Nitrógeno disponible en el suelo fue de 0.16%, equivalente a 64.6 kg ha<sup>-1</sup> (figura 3). En el segundo muestreo hubo un incremento en el porcentaje de *N* en todos los socios y el manejo tradicional. Esto se debe a que los abonos verdes contienen nutrientes que son liberados al suelo según se van descomponiendo, además incrementaron el contenido de materia orgánica haciendo que los nutrientes sean mas accesibles. En el manejo tradicional, el aumento se debió a la fertilización mineral que se realizó aquí con sulfato de amonio y a la incorporación de las arvenses que quedaron en las parcelas después e las limpias. En el tercer muestreo, los socios que incrementaron el porcentaje de *N* disponible en el suelo fueron: *D. lablab* y *M. pruriens* con 0.48 y 0.30% respectivamente (191 y 118.4 kg ha<sup>-1</sup>). Es importante destacar que las cantidades de *N* disponibles encontrados en el suelo fueron superiores a estos por LÓPEZ y GUIDO (1996), quienes recomiendan una fertilización nitrogenada de 80 kg ha<sup>-1</sup> en el cultivo de la pitahaya. De esto se puede inferir, que mediante el aporte de *N* por parte de los abonos verdes

**Tabla 1:** Influencia de diferentes coberturas verdes sobre el rendimiento de pitahaya, la producción de biomasa por cobertura verde y arvenses y el uso equivalente de tierra.

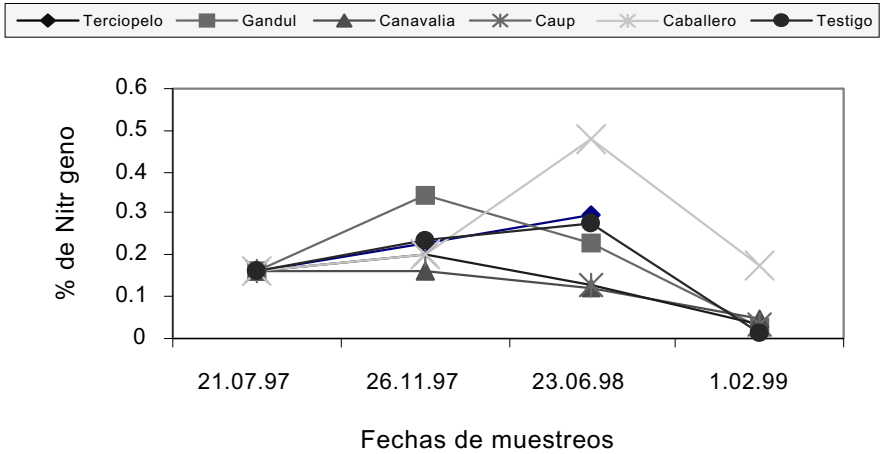
Tratamientos	Rendimiento de la pitahaya (kg ha <sup>-1</sup> )	Biomasa de la cobertura verde (kg ha <sup>-1</sup> )	Biomasa de las arvenses (kg ha <sup>-1</sup> )	UET = $\sum$ de los rendimientos (kg ha <sup>-1</sup> )
<i>Ciclo 1997-98</i>				
a1 <i>M. pruriens</i>	2, 663.3	6, 721.0	0	9, 384.3
a2 <i>C. cajan</i>	2, 798.8	7, 077.8	0	9, 876.6
a3 <i>C. ensiformis</i>	2, 237.9	7, 185.0	100.0	9, 522.9
a4 <i>V. unguiculata</i>	2, 249.4	3, 934.6	1, 437.3	7, 621.3
a5 <i>D. lablab</i>	2, 278.5	5, 212.3	0	7, 490.8
a6 Manejo tradicional	1, 565.1	0	3, 176.6	4, 741.7
<i>Ciclo 1998-99</i>				
a1 <i>M. pruriens</i>	-	-	-	-
a2 <i>C. cajan</i>	13,354.4	7,000.0	1,700.0	22,054.4
a3 <i>C. ensiformis</i>	12,470.0	7,000.0	200.0	19,670.0
a4 <i>V. unguiculata</i>	12,766.0	4,000.0	1,957.0	17,723.0
a5 <i>D. lablab</i>	23,338.7	5,000.0	0	28,338.7
a6 Manejo tradicional	4,361.8	0	2,800.0	7,161.8

no es necesario realizar fertilización mineral. El último muestreo fue realizado después del huracán Mitch. Se encontró un descenso drástico de *N* disponible en todos los tratamientos, que se atribuye a los efectos negativos causados por este fenómeno natural.

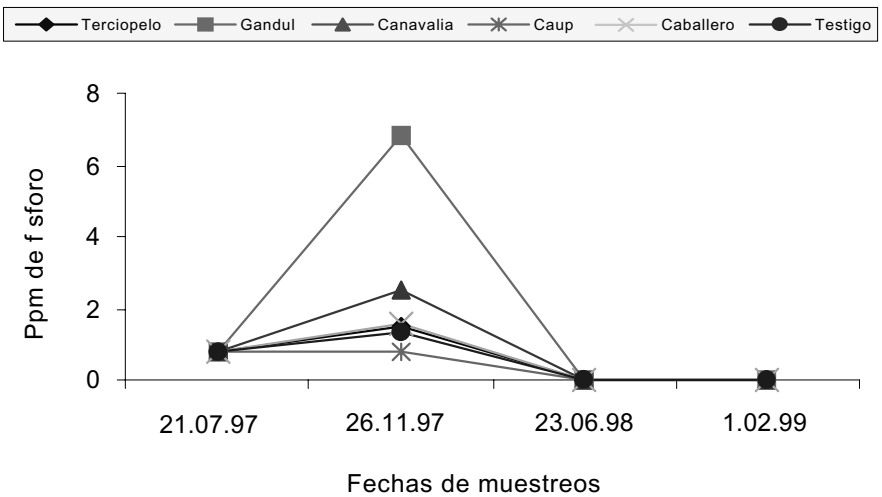
### 3.4 Fósforo

Antes de establecer las coberturas verdes en asocio con pitahaya el Fósforo disponible para la planta fue de 0.77 ppm, 1.54 kg ha<sup>-1</sup> (figura 4), al asociar los abonos verdes se incrementaron los contenidos de Fósforo en todos los tratamientos. Cabe destacar que en los asociados con *C. cajan*, *C. ensiformis* y *D. lablab*, fue donde hubieron los mayores incrementos con 6.8, 2.54 y 1.53 ppm, (13.6, 5.08 y 2.94 kg ha<sup>-1</sup>). El aumento de los contenidos de *P* en el suelo se debe al aporte de material vegetal de los abonos verdes, que incrementaron la materia orgánica y favorecieron los contenidos de *P* asimilable. El tratamiento que presentó el menor incremento de *P* fue el manejo tradicional con 1.35 ppm. Los resultados obtenidos están por debajo de los recomendados por LÓPEZ y GUIDO (1996), quienes afirman que éste cultivo necesita aproximadamente 20 kg ha<sup>-1</sup>

**Figura 3:** Nitrógeno disponible en el suelo de los diferentes tratamientos.



**Figura 4:** Fósforo disponible en el suelo de los diferentes tratamientos.



de *P* para su normal crecimiento y desarrollo. Podemos inferir que al asociar el cultivo de pitahaya con estas coberturas verdes es necesario realizar una fertilización fosfórica que nos garantice éste elemento a través de guano, gallinaza, roca fosfórica, etc.

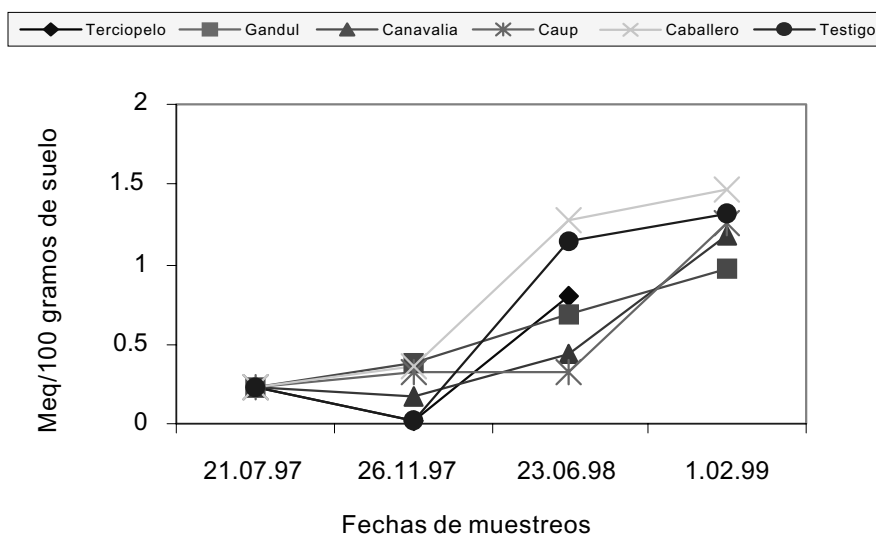
### 3.5 Potasio

El Potasio disponible en el suelo antes de asociar los abonos verdes con la pitahaya fue de 0.23 meq, 215.28 kg ha<sup>-1</sup> (figura 5), el cual es superior al escrito por LÓPEZ y GUIDO



(1996), quienes estiman una fertilización potásica de  $100 \text{ kg ha}^{-1}$ . En el segundo muestreo hubo incrementos en los asociados con *C. cajan*, *D. lablab* y *V. unguiculata* con 0.39, 0.36, 0.32 meq, ( $365.04$ ,  $336.96$ ,  $299.52 \text{ kg ha}^{-1}$ ). En contra a estos hubo un descenso drástico en los tratamientos con *M. pruriens* y manejo tradicional, con 0.02 meq. Con esto se comprueba que existen especies de abonos verdes que son más extractoras de éste elemento y que a través del reciclaje de sus residuos, a corto plazo, éste no es devuelto al suelo. No obstante, en el tercero y último muestreo se constató un incremento de este elemento en todos los asociados y en el manejo tradicional. Es importante destacar que en el tratamiento con manejo tradicional, el contenido de *K* fue al final de 1.31 meq., esto se atribuye a la cantidad de *K* exportable por las especies de malezas y a la fertilización realizada en este tratamiento.

**Figura 5:** Potasio disponible en el suelo de los diferentes tratamientos.



#### 4 Crecimiento y Rendimiento de la Pitahaya

En el cultivo de la pitahaya el crecimiento se puede tipificar a través de diferentes variables como: número y longitud de brotes, número de vainas, grosor, peso fresco y seco de vainas (SALAZAR y POHLAN, 1999). La importancia de algunas de éstas variables es que son componentes directos en la producción de frutos. La brotación es un componente directo en la producción de frutos (BOLAÑOS y LOPEZ, 1996), dado que al presentar mayor número de brotes aumentará la posibilidad de que las vainas al entrar a la fase reproductiva puedan producir más frutos. El fruto de la pitahaya tiene diferentes usos. Para el consumo humano se prepara como jugos, dulces, jaleas, cóctel, cerveza y vino. Se afirma que las semillas que se consumen con la pulpa, contienen un aceite que evita los cólicos ayudando al buen funcionamiento del estómago y los intestinos. La pulpa contiene una sustancia llamada cáptina que actúa como tónico del corazón y como calmante de los nervios. La cáscara se puede usar como forraje para

el ganado. La producción de pitahaya comprende in Nicaragua de Junio a Noviembre, durante la cual pueden efectuarse hasta cinco cortes, llamados ciclos de producción (INTA, 1996).

#### 4.1 Numero y longitud de brotes

En el ciclo 1997-98, se pudo constatar un mayor número de brotes al asociar la pitahaya con *C. cajan*, *V. unguiculata* y *M. pruriens* (9 a 7 por planta). Por el contrario, los asociados con *D. lablab* y *C. ensiformis* presentaron una menor brotación, cuyos valores son similares al tratamiento manejo tradicional (6 por planta). Estos resultados reflejan el aporte de nutrientes a través de la materia orgánica por los diferentes abonos verdes. La producción de brotes nuevos en 1998-99 no fue tan alto como en el 1° ciclo. Los tratamientos que presentaron mayor número de brotes fueron *V. unguiculata*, *C. cajan* y *C. ensiformis* (5 por planta), obteniendo resultados similares en *D. lablab* y en el tratamiento manejo tradicional (4 por planta).

En 1997-98, Lisa fue el clon, que presentó con 10 brotes por planta la mayor cantidad seguido por Cebrá y Orejona (7 por planta). En 1998-99, el clon Cebrá fue el que presentó mayor cantidad de brotes (11 por planta), seguido de Lisa con nueve y Orejona con ocho por planta. Esto permite concluir, que el clon Orejona tiene un menor potencial de brotación que Lisa y Cebrá, cuyo comportamiento en ambos años fue diferente. Estos resultados nos determinan que al asociar la pitahaya con *C. cajan*, *C. ensiformis* y *V. unguiculata* se favorece la brotación de la pitahaya.

La longitud de los brotes es una variable de crecimiento muy importante ya que los brotes que presentan mayor longitud formaran vainas de mayor tamaño, aumentando la posibilidad de formar más frutos. Los resultados obtenidos demuestran que en los dos ciclos no se encontró diferencias significativas entre las diferentes coberturas verdes y el manejo tradicional (tabla 2). Numéricamente el manejo tradicional y *M. pruriens* presentaron con 9.0 cm el mayor valor en la longitud de brotes seguido en orden descendente por *D. lablab*, *C. cajan*, *V. unguiculata* y *C. ensiformis* con 9.0, 8.5, 8.4 y 8.3 cm respectivamente. En relación a los clones, en el año 1997-98 se encontraron diferencias significativas, ocupando el primer lugar el clon Orejona con un valor promedio de 9.4 cm, seguido por los clones Cebrá y Lisa con 8.7 cm y 8.4 cm respectivamente (tabla 2). Estos resultados se deben a que el clon Orejona tiene un menor potencial de brotación lo que permite que el crecimiento longitudinal de sus brotes sea mayor.

#### 4.2 Diámetro polar y ecuatorial del fruto

En el cultivo de la pitahaya la variable, diámetro de fruto, es muy importante para la producción, principalmente, cuando se destina al mercado internacional. Éste lo clasifica en dos grupos: Grupo I de 6-8 cm y Grupo II de 9-12 cm. Los resultados del primer ciclo no demostraron diferencias significativas en el diámetro polar y ecuatorial del fruto de pitahaya (tabla 2). En 1998-99 los resultados muestran diferencias significativas en el diámetro polar en los tratamientos y en los clones, siendo *V. unguiculata* y *C. ensiformis* y el clon Lisa los que alcanzaron mayores valores. Esto nos hace inferir que el efecto

**Tabla 2:** Influencia de diferentes coberturas verdes sobre la longitud de brotes y el diámetro de frutas de pitahaya.

Tratamientos	Longitud de brotes (cm)		Diámetro polar (cm)		Diámetro ecuatorial (cm)	
	1997-98	1998-99	1997-98	1998-99	1997-98	1998-99
a1 <i>M. pruriens</i>	9.0 <sup>a</sup>	-	8.9 <sup>a</sup>	-	6.9 <sup>a</sup>	-
a2 <i>C. cajan</i>	8.5 <sup>a</sup>	8.3 <sup>a</sup>	8.6 <sup>a</sup>	12.2 <sup>ab</sup>	6.5 <sup>a</sup>	7.2 <sup>a</sup>
a3 <i>C. ensiformis</i>	8.3 <sup>a</sup>	8.1 <sup>a</sup>	8.9 <sup>a</sup>	13.3 <sup>ab</sup>	6.7 <sup>a</sup>	7.4 <sup>a</sup>
a4 <i>V. unguiculata</i>	8.4 <sup>a</sup>	8.6 <sup>a</sup>	8.8 <sup>a</sup>	13.3 <sup>a</sup>	6.6 <sup>a</sup>	6.8 <sup>a</sup>
a5 <i>D. lablab</i>	8.5 <sup>a</sup>	8.9 <sup>a</sup>	8.3 <sup>a</sup>	10.8 <sup>b</sup>	6.7 <sup>a</sup>	7.3 <sup>a</sup>
a6 Manejo tradicional	9.0 <sup>a</sup>	10 <sup>a</sup>	8.4 <sup>a</sup>	11.1 <sup>ab</sup>	6.5 <sup>a</sup>	7.0
Significancia	N.S	N.S	N.S	*	N.S	N.S
C.V %	6.3	13.1	6.8	10.6	7.2	5.5
<i>Clones</i>						
Orejona	9.4 <sup>a</sup>	9.1 <sup>a</sup>	8.5 <sup>a</sup>	11.5 <sup>b</sup>	6.6 <sup>a</sup>	7.3 <sup>a</sup>
Lisa	8.4 <sup>b</sup>	8.2 <sup>a</sup>	8.4 <sup>a</sup>	13.4 <sup>a</sup>	6.6 <sup>a</sup>	7.6 <sup>a</sup>
Cebra	8.7 <sup>b</sup>	9.1 <sup>a</sup>	8.5 <sup>a</sup>	13.2 <sup>ab</sup>	6.4 <sup>a</sup>	7.3 <sup>a</sup>
San Ignacio	-	8.7 <sup>a</sup>	-	12.0 <sup>ab</sup>	-	7.3 <sup>a</sup>
Significancia	*	N.S	N.S	*	N.S	N.S
C.V %	2.6	4.4	8.2	3.4	5.3	4.7

N.S = No significativo; \* = Significativo; C.V = Coeficiente de variación

de los abonos verdes sobre el diámetro polar del fruto se manifiesta en el segundo ciclo agrícola.

### 4.3 Número de frutos

Los socios que presentaron la mayor cantidad de frutos por hectárea en el ciclo 1997-98 fueron *C. cajan* y *M. pruriens* con 10.250 y 8.375 respectivamente. *D. lablab*, *V. unguiculata* y *C. ensiformis* mostraron una cantidad de frutos ligeramente superior al tratamiento con manejo tradicional, cuyos valores oscilaban entre 7.375 y 6.375 frutos/ha. En el ciclo 1998-99 los socios que obtuvieron mayor cantidad de frutos fueron de nuevo *D. lablab*, seguido de *C. cajan*, *V. unguiculata* y *C. ensiformis* con 19.300, 13.050, 13.050, 12.500 frutos/ha. El menor número alcanzó el manejo tradicional con 12.150 frutos/ha.

Normalmente se cuenta en los sistemas tradicionales con una cantidad promedio de 4.000 frutos por hectárea en plantaciones de dos años de establecidas (HESSEN, 1994). Estos resultados nos demuestran que la práctica de cultivar cobertura verde entre las hileras de pitahaya tiene efectos positivos en cuanto al prendimiento de flores, lo que se refleja en un mayor número de frutos. Los clones Orejona, Lisa, y San Ignacio son considerados de buena productividad y el clon Cebra de muy alta productividad. En este estudio el clon Orejona es el que presentó el mayor número de frutos por hectárea en ambos ciclos agrícolas. Al establecer plantaciones de pitahaya con el clon Orejona se tienen ciertas ventajas y desventajas. Entre las ventajas tenemos que es un clon resistente a la bacteriosis (*Erwinia carotovora* Smith), que es una de las enfermedades que más afecta al cultivo de la pitahaya, es menos atacada por insectos plagas y es bien productivo. Las desventajas son que es susceptible a otras enfermedades como antracnosis (*Colletotrichum gloeosporioides* Penz.) y ojo de pescado (*Dothiorella* spp.).

#### 4.4 Número de frutos dañados

Las pérdidas en frutos dañados se debe al ataque de pájaros y algunas especies reptiles como iguanas y lagartijas. El asocio en que se presentaron más frutos dañados fue con *C. cajan*, en ambos ciclos con 375 y 200 frutos/ha, seguido por *C. ensiformis*, con 135 y 125 frutos/ha, *V. unguiculata* y *D. lablab* con 125, 119, 125, 120 frutos/ha respectivamente. El tratamiento con manejo tradicional presentó solamente 30 frutos dañados por hectárea.

#### 4.5 Peso del fruto

El peso de fruto tiene importancia sobre todo cuando el destino de la producción es para el mercado internacional y se tiene que clasificar de acuerdo a las categorías exigidas por éste, las cuales son: categoría I de 200 a 400g y categoría II de 410 a 500g (INTA, 1996).

En el ciclo de 1997-98 los tratamientos que presentaron mayor peso de frutos fueron *C. ensiformis*, *M. pruriens* y *V. unguiculata*, con 337.8, 318 y 305 gramos. Los menores pesos se obtuvieron en los tratamientos con *D. lablab*, *C. cajan* y el tratamiento con manejo tradicional con 294, 273 y 245.5 gramos. Estos rangos no fueron encontrados en el próximo ciclo 1998-99, cuando los tratamientos que presentaron los mejores pesos fueron *D. lablab*, el manejo tradicional y *C. ensiformis* con 403, 359 y 344 gramos y los que presentaron los menores pesos fueron *V. unguiculata* y *C. cajan* con 326 y 341 g por pitahaya.

El comportamiento del peso del fruto, en los diferentes clones existentes en la plantación, fue heterogéneo. En el primer ciclo, en 1997-98 el clon San Ignacio no floreció. Sin embargo en 1998, éste clon fructificó abundante y presentó frutos más pesados. Es importante destacar que los clones Cebra, Lisa, y Orejona alcanzaron mayores pesos de frutos en el segundo ciclo agrícola. En el último ciclo agrícola, prácticamente, todos los clones mostraron pesos de frutos muy similares cuyos valores oscilaron entre 322 y 376.6 gramos.

#### 4.6 Rendimiento de la pitahaya

En 1997-98 los mejores rendimientos se obtuvieron en las parcelas con *C. cajan* y *M. pruriens* alcanzando 2.798 y 2.663 kg ha<sup>-1</sup> (tabla 1). El menor rendimiento se determinó en el tratamiento con manejo tradicional con 1.565.1 kg ha<sup>-1</sup>, causado especialmente por la formación de menos frutos. También en el segundo ciclo dominaron los tratamientos con cobertura verde. El mayor rendimiento lo presentaron las parcelas con *D. lablab*, dado que en éstas parcelas los frutos eran más pesados y había un mayor número de frutos por planta. El menor rendimiento se determinó en las parcelas con manejo tradicional. Estos resultados nos inducen a afirmar que en plantaciones de pitahaya, se necesita que en cada ciclo agrícola, durante la época lluviosa, se siembren abonos verdes para poder aprovechar sus beneficios y contribuir a la estabilidad ecológica del agroecosistema, lo que se traduce en mayores rendimientos y se mejorará, de ésta forma el nivel de vida de los productores. En ambos ciclos agrícolas, el clon Orejona es el que presentó los mejores rendimientos (2942 y 2547 kg ha<sup>-1</sup>).

#### 5 Sistemas de Uso Equivalente de la Tierra (UET)

El uso equivalente de la tierra es el área relativa de terreno bajo un cultivo que sería necesaria para obtener rendimientos de asocio. Mediante el asocio de cobertura viva con pitahaya se aumentó la eficiencia en la utilización de la tierra, obteniendo claras ventajas bajo este sistema (tabla 1). El asocio con abonos verdes mejoró las propiedades químicas del suelo. Además se redujeron los insectos plagas y se fomentó la presencia de insectos benéficos. Las especies promisorias para el manejo cultural de insectos fueron: *M. pruriens*, *C. cajan* y *D. lablab*. Es importante que con el asocio de *D. lablab*, *C. ensiformis* se disminuyó la incidencia de *Colletotrichum gloeosporioides*, *Dothiorella* spp. y *Erwinia carotovora*. El clon Lisa fue el más susceptible.

#### Agro-biological Effects of Green Covers in Pitahaya Cropping Systems (*Hylocereus undatus* Britton & Rose) in Nicaragua

##### Abstract

The effect of different green cover plants (*Mucuna pruriens*, *Cajanus cajan*, *Canavalia ensiformis*, *Vigna unguiculata*, *Dolichos lablab*) and traditional cropping at the content of organic matter and macronutrients in the soil, the biomass production, the presents of pests, and growth and yield parameters of four pitahaya clones was studied during two years in an field experiment, which was realized in Masaya - Tipitapa. The treatments with *M. pruriens*, *C. cajan* and *C. ensiformis* produce more biomass and increase the content of organic matter and *NPK* in the soil. In both years the highest yield was obtained with the clon Orejona (2942 and 2547 kg ha<sup>-1</sup>). The number of fruits, the pitahaya yield and the soil use ratio was higher in the systems with cover crops than in the traditional cropping system.

Keywords: *Hylocereus undatus*, green cover, organic matter, macronutrients, growth, yield, soil use ratio

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## Response of *Sesbania* Green Manuring and Mungbean Residue Incorporation on Microbial Activities for Sustainability of a Rice-Wheat Cropping System

K.V.B.R. Tilak<sup>1</sup>

### Abstract

The microbial population and its biomass and nitrogenase activity in plant roots under sandy-clay-loam soil conditions where the plant residues of *Sesbania rostrata* and mungbean (*Vigna radiata*) were incorporated were significantly higher than that obtained from summer fallow. The increases in yield of rice and wheat and the total nitrogen content in shoot and grain was also perceptible by the application of green manuring. The results highlight the importance of green manuring in rice-wheat cropping systems under tropical sandy-clay-loam soil conditions of India.

**Keywords:** green manuring, rice-wheat cropping system, microbial activities

### 1 Introduction

Rice-wheat system is the most wide-spread cropping system in each of the five Asian-Pacific regions. It covers about 22 million hectares in South-East Asia stretching over large areas in India, Pakistan, Nepal, Bangladesh and China. In India it occupies about 10 million hectares and almost 73 per cent of the food requirement of the country is met by rice and wheat. This proportion is likely to increase to almost 77 per cent by the year 2010. Data from long term experiments, however, present a disturbing trend on sustainability of rice-wheat cropping system. The yield levels of both rice and wheat are either plateauing or registering a declining trend particularly in high productivity regions of the country. There is a general decline in factor productivity and farmers have to use more and more fertilizer year after year to get the same level of yield as obtained with less amount of fertilizers in the previous years. This has been occurred due to decline in soil organic matter which led to impoverishment of soil fertility. Inclusion of a legume in cropping systems is an old established measure for recouping impoverished soil fertility. The usage and limitation of green manuring in low land rice has been reported (BECKER *et al.*, 1995; BECKER and LADHA, 1997; BECKER, 2001). The soil microbial population is closely associated with organic matter of soil. Immediately after incorporation into soil, plant materials are subjected to the transformation and decomposition process of heterotrophic microflora (NEGI *et al.*, 1986, 1987; RAUHE, 1987; SINGH and SINGH, 1993; TILAK *et al.*, 1995). However, data on the effect of legumes, particularly when their residue is incorporated on biological properties of soil are, however, meagre. The present report deals with the effect of green manuring with *Sesbania aculeata* and

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<sup>1</sup> Institut für Pflanzenbau und Tierhygiene in den Tropen und Subtropen, Georg-August-Universität, Grisebachstr. 6, D-37077 Göttingen, Germany. Email: tilakkvbr@yahoo.com



*S. rostrata* and mungbean (*Vigna radiata*) residue incorporation on soil microbial population, microbial biomass, nitrogenase activity in roots, nitrogen content in shoot and grain and yields of straw and grain of rice and wheat crops.

## 2 Materials and Methods

### 2.1 Soil

A green house experiment was conducted with sandy-clay-loam soil having 52.5% sand, 21.0% silt and 26.5% clay, pH 8.2 (1:2:5 soil to 0.01M CaCl<sub>2</sub> solution), 0.60% organic carbon, 36 mg alkaline permanganate hydrolysable N per kg soil, 10 mg 0.5N NaHCO<sub>3</sub> extractable P per kg soil and 140 mg 1N ammonium acetate extractable K per kg soil.

### 2.2 Details of experiment

The experiment was laid out in cement pots having 20 kg of soil with five replications. The treatments were fallow, *Sesbania aculeata* green manuring, *S. rostrata* green manuring, mungbean (SR - both grain and residue harvested) and mungbean (SI - grain harvested and residue incorporated in soil) during summer (mid April - end June 2002).

Summer crops were seeded in the third week of April. *Sesbania* as well as mungbean received a basal dose of 20 kg N ha<sup>-1</sup> as urea and 17 kg P ha<sup>-1</sup> as single super phosphate. Fallow pots received no fertilizer during summer. Both species of *Sesbania* were grown to flowering (60 days) and then incorporated into soil as green manure. Mungbean variety P-16 was grown to maturity (65-70 days after sowing) and in one set of pots all aboveground vegetation was removed, whereas in second set of pots the matured pots were picked by hand and the remaining residue was incorporated into soil while preparing for rice transplantation.

For rice, the pots were flooded with water, tilled and puddled. 60 kg N ha<sup>-1</sup> as urea, 20 kg P ha<sup>-1</sup> as single super phosphate, 30 kg K ha<sup>-1</sup> as muriate of potash and 4 kg Zn ha<sup>-1</sup> as zinc sulphate hepta hydrate were applied to each pot. Three seedlings per hill of 25-30 days old of rice variety Pusa 169 were transplanted in the second week of July into each pot. Nitrogen was applied in two equal splits, 10 days and 30 days after transplanting rice. The plants were harvested in the last week of October.

For wheat, the pot was irrigated after harvesting rice and prepared for sowing. A basal dose of 40 kg N ha<sup>-1</sup> as urea, 20 kg P ha<sup>-1</sup> as single super phosphate and 30 kg ha<sup>-1</sup> as muriate of potash was applied. Three seedlings were allowed to grow in each pot. Wheat variety HD 2329 was sown in the last week of November and harvested in the third week of April.

### 2.3 Microbial assay

Microbial population and activities in soil were evaluated for each crop at 60 days of plant age. Three soil samples from 0-6 cm depth were collected from each replicate and composited. The soil was sieved through a 2 mm mesh screen after visible plant debris and fauna had been removed. Samples from different replicates were air dried

and analysed for various microbial counts by plating appropriate dilutions of soil solution in respective media and incubated at 30°C.

The bacterial and actinomycetes colonies were counted on soil extract agar (ALLEN, 1957) and fungal colonies on Rose Bengal agar medium (PARKINSON, 1973). The enumeration of *Azospirillum* was carried out by the most-probable-number (MPN) method using sodium malate semi-solid medium (DOBEREINER *et al.*, 1976). The MPN counts were calculated as per the tables outlined by ALEXANDER (1965). The phosphate solubilising bacteria (PSB) present in soil were counted by using a medium suspended with insoluble phosphate like tri-calcium phosphate. The production of clearing zones around the colonies is an indication of the presence of PSB (SUNDARARAO and SINHA, 1963). All microbial counts were expressed as  $X \times 10^x$  per g of soil on air dry basis in each case.

The nitrogenase activity in root was estimated at 60 days of plant age by the acetylene reduction assay as described by TRIPATHI and KLINGMULLER (1992).

The soil microbial biomass C was estimated by fumigation extraction method (VANCE *et al.*, 1987). It was expressed as  $\mu\text{g}$  per g oven dry soil (JENKINSON, 1988).

## 2.4 Plant parameters

The shoot biomass on dry weight basis and grain yield were recorded at the time of plant harvest. The total nitrogen content in shoot and grain was also determined after harvest by Kjeldahl method (PAGE *et al.*, 1982).

## 2.5 Statistical analyses

The data were analysed statistically as described by FISCHER (1958). The critical difference at 5% significance level was calculated.

## 3 Results and Discussion

The role of soil microorganisms in sustainable productivity has been reviewed (LEE and PANKHURST, 1992; LATA *et al.*, 2000). Microbes including bacteria, fungi and actinomycetes are the principal decomposers of organic matter in soil. In the present study the population of bacteria, fungi, *Azotobacter* and *Azospirillum* was much larger during rice growth period than that during wheat growth period, whereas the population of actinomycetes was much higher during wheat growth period than during rice growth period. The population of phosphate solubilising bacteria (PSB) remained more or less similar during both the cropping periods.

*Sesbania* green manuring significantly increased the microbial population many fold over fallow; *S. rostrata* had more beneficial effect on microbial population than *S. aculeata*. As compared to fallow *S. aculeata* increased the population of bacteria, actinomycetes, fungi, *Azospirillum*, *Azotobacter* and PSB by 2.3, 3.7, 5.0, 3.2, 5.3 and 2.8 times, respectively during rice growth period and 1.7, 12.0, 1.7, 2.3, 2.0 and 2.5 times, respectively during wheat growth period, whereas *S. rostrata* green manuring increased population of bacteria, actinomycetes, fungi, *Azotobacter*, *Azospirillum* and PSB over fallow by

3.7, 16.3, 9.0, 4.8, 33.0 and 13.5 times, respectively during rice growth period and 2.3, 12.8, 3.0, 5.5, 75.0 and 3.0 times, respectively during wheat growth period. Growing mungbean also resulted in higher microbial population as compared to fallow and the results were quite encouraging when its residue was incorporated. It is interesting to note that the *Azospirillum* counts in soil was more in these soils than in others (Table 1). Reports indicate that green manuring with crimson clover (*Trifolium incarnatum*) in soil brought in significantly more number of *Bacillus* sp., actinomycetes and total culturable bacteria than did the soil from N fertilized, conventionally tilled treatment without green manuring (KIRCHNER *et al.*, 1993).

**Table 1:** Effect of summer crops and their residue on soil microbial population

Treatment	Microbial population (per g soil)					
	Bacteria 10 <sup>5</sup>	Actinomycetes 10 <sup>4</sup>	Fungi 10 <sup>4</sup>	Azotobacter 10 <sup>2</sup>	Azospirillum 10 <sup>4</sup>	PSB 10 <sup>2</sup>
<i>Rice</i>						
Fallow	42	0.3	0.1	22	0.9	0.4
<i>Sesbania aculeata</i>	95	1.1	0.5	67	4.8	1.1
<i>Sesbania rostrata</i>	155	4.9	0.9	105	29.7	5.4
Mungbean (SR)	105	1.2	0.8	87	15.5	3.5
Mungbean (SI)	167	5.5	1.3	202	37.5	6.0
C.D. at 5%	40.5	1.25	0.72	25.8	10.7	0.9
<i>Wheat</i>						
Fallow	32	0.4	0.3	11	0.01	2.1
<i>S. aculeata</i>	55	4.8	0.5	25	0.02	5.2
<i>S. rostrata</i>	75	5.1	0.9	60	0.75	6.3
Mungbean (SR)	35	3.8	0.5	42	0.32	4.8
Mungbean (SI)	67	9.5	0.8	68	0.62	5.1
C.D. AT 5%	18.5	25.5	0.2	10.5	0.022	0.75

SR: both grain and straw harvested; SI: grain harvested but straw incorporated

The microbial biomass in soil, in general, was more in 0-15 cm depth than in 15-30 cm layer. *S. rostrata* green manuring resulted in highest microbial biomass C followed by mungbean residue incorporation and *S. aculeata* green manuring (Table 2). Mungbean without residue incorporation has no added advantage over fallow which resulted in lowest microbial biomass at both depths of soil.

**Table 2:** Effect of summer crops on microbial biomass\* at 0-15 cm and 15-30 cm soil depth.

<i>Treatment</i>	<i>Rice</i>		<i>Wheat</i>	
	<i>0-15 cm</i>	<i>15-30 cm</i>	<i>0-15 cm</i>	<i>15-30 cm</i>
Fallow	192.1	156.5	119.5	102.8
<i>S. aculeata</i>	250.0	192.7	235.6	187.5
<i>S. rostrata</i>	285.0	210.5	305.7	220.5
Mungbean (SR)	200.5	155.5	205.8	105.8
Mungbean (SI)	244.0	195.7	302.7	208.7
C.D. at 5%	35.58	21.24	42.75	35.56

\* Microbial biomass expressed as  $\mu\text{g C}$  per g soil

The nitrogenase activity as determined by ARA technique revealed significant variations among the treatments. The activity was more in green manuring with *S. rostrata* and mungbean residue incorporation treatments (Table 3). Both the legumes are nodulating plant species and *S. rostrata* forms stem nodules in addition to root nodules. Contributions of legume-*Rhizobium* symbiotic system in augmenting soil fertility in various cropping systems have been well documented (CHALK, 1998). A number of nitrogen-fixing bacteria including rhizobia are considered to be growth promoting rhizobacteria (PGPR). The effects of PGPR on plant growth can be mediated through the production of phytohormones or by supplying biologically fixed nitrogen (GLICK, 1995).

The yields of straw and grain were significantly more under green manuring treatments than under fallow. Green manuring with *S. aculeata* and mungbean incorporation without residue resulted not much significant variation in straw and grain yield of rice and wheat. The differences between various amendments on dry shoot biomass and grain yield of wheat were not significant although they were superior to fallow treatment (Table 3). The total nitrogen content in shoot and grain at the time of harvest showed significant variations among various treatments (Table 4).

Management practices that conserve the biodiversity of microbial communities in marginal soils can sustain agricultural production over long periods of time. In this context, growing the green manure crops like *S. rostrata* or mungbean during rice-wheat cropping system is one of the ideal management practices for improving soil fertility and crop productivity. Rice and wheat being important cereal crops showing low productivity in marginal lands, these results will impart information for ameliorating soil quality and increase the unit land productivity. Legumes being an integral part of agriculture, the rhizobial partner and associated microflora in soil play a vital role in influencing soil quality and crop productivity.

**Table 3:** Effect of summer crops on shoot dry biomass, grain yield and nitrogenase activity of root of rice and wheat.

Treatment	Rice*			Wheat†		
	Shoot dry biomass (g)	Grain yield (g)	Nitrogenase activity‡	Shoot dry biomass (g)	Grain yield (g)	Nitrogenase activity‡
Fallow	12.5	4.2	5.2	15.8	4.8	6.2
<i>S. aculeata</i>	20.7	6.7	28.5	22.7	9.5	30.7
<i>S. rostrata</i>	38.5	10.8	102.8	30.5	11.5	85.6
Mungbean (SR)	25.7	6.5	32.5	25.7	8.7	35.8
Mungbean (SI)	35.5	9.3	86.5	27.5	10.2	75.7
C.D. at 5%	8.12	1.75	2.55	5.75	4.58	3.47

\* per hill consisting of 5-6 fertile tillers

† per three plants

‡ nitrogenase activity in root ( $n \text{ mol C}_2\text{H}_4 \text{ h}^{-1}\text{g}^{-1}$  root) of rice and wheat

**Table 4:** Effect of summer crops on total nitrogen content in shoot and grain of rice and wheat.

Treatment	Total N content (mg per g dry weight)			
	Rice		Wheat	
	Shoot	Grain	Shoot	Grain
Fallow	3.5	11.8	4.2	13.5
<i>S. aculeata</i>	4.7	12.5	5.9	15.4
<i>S. rostrata</i>	7.5	14.5	9.2	19.8
Mungbean (SR)	5.8	13.5	7.8	16.2
Mungbean (SI)	6.5	14.7	9.2	18.5
C.D. at 5%	0.95	0.58	1.55	1.25

#### 4 Summary

The microbial counts viz. bacteria, actinomycetes, fungi, *Azotobacter*, *Azospirillum*, PSB, the microbial biomass in soil and nitrogenase activity in roots were markedly higher in soil where green manuring with *Sesbania rostrata*, *S. aculeata* and green gram (*Vigna radiata*) was incorporated than in fallow soil. *Sesbania rostrata* brought 148.2 and 258.8 percent increase in microbial biomass over fallow treatment with rice and wheat,

respectively at 0-15 cm soil depth closely followed by mungbean residue incorporation in soil. Similar trend was noticed with the nitrogenase activity which was 19.8 and 13.8 times higher than the fallow soil with rice and wheat, respectively due to *S. rostrata* green manuring. This was reflected in better performance of rice and wheat as evidenced by the increase in dry shoot biomass, grain yield and total N content in shoot and grain at harvest under green house conditions. The increase in shoot dry biomass and grain yield due to *S. rostrata* green manuring over no amendment was 3.1, and 2.5 times, respectively with rice and 1.9 and, 2.4 times, respectively with wheat.

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## **Эпизоотология туберкулеза крупного рогатого скота в различных зонах Таджикистана**

**Д. М. Мирзоев<sup>1</sup>, В. Драушке<sup>2</sup> \***

### **1 Введение**

За годы Советской власти в Средней Азии, в частности в республике Таджикистан, проводилась интенсивная борьба с туберкулезом крупного рогатого скота, в результате чего оздоровлены многие неблагополучные пункты. Однако анализ материалов по ликвидации туберкулеза показывает, что несмотря на проводимые в республике мероприятия, заболеваемость крупного рогатого скота туберкулезом в 1988 г. не снижалась.

Тщательный анализ отчетных данных Главного управления ветеринарии республики за последние 51 год показал, что с увеличением охвата туберкулинизации крупного рогатого скота наблюдается рост его заболеваемости туберкулезом. При этом уровень заболеваемости в республике остается ещё достаточно высоким.

В связи с этим мы попытались, как протекает туберкулез у крупного рогатого скота в различные периоды.

### **2 Материалы и методы**

Течение туберкулеза крупного рогатого скота изучали в различные периоды в неблагополучных хозяйствах республики. При этом учитывали количество неблагополучных пунктов, источники и пути распространения инфекции, систему ведения животноводства, концентрацию и данные республиканского архива и ветеринарной отчетности главного управления ветеринарии республики.

При выявлении закономерностей распространения туберкулеза в разрезе республики проводили анализ заболеваемости за 51 год (с 1943 по 1994 гг.).

### **3 Результаты исследований**

Заболеваемость животных туберкулезом в условиях республики Таджикистан регистрируется до настоящего времени. Развитие мероприятий по борьбе с туберкулезом можно разделить на несколько периодов.

**ПЕРВЫЙ ПЕРИОД (1943-1961 гг.).** Этот период, который можно назвать организационным, совпадает с развитием ветеринарной науки, когда в 1943 г. на базе республиканской ветеринарной лаборатории была создана научно-исследовательская опытная станция.

В 1956 г. при АКАДЕМИИ НАУК Таджикской ССР был организован научно -

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<sup>1</sup> Таджикский Аграрный университет, 73401 г. Душанбе, пр. Рудаки 146.

<sup>2</sup> Университет г. Лейпциг, 04289 Лейпциг, ул. Росеггер.

\* corresponding author



исследовательский институт животноводства и ветеринарии.

В 1961 г. в целях дальнейшего развития ветеринарной науки в республике был организован научно-исследовательский ветеринарный институт.

В связи с развитием птицеводства в республике расширились исследования по эпизоотологии, патогенезу и иммунитету инфекционных заболеваний птиц. В план научных исследований включены работы по пастереллезу, туберкулезу птиц (И. Ф. Пустовой 1965 г.). За этот период (с 1943 по 1960 гг.) данных о распространении туберкулеза в доступной Литературе не найдено.

**ВТОРОЙ ПЕРИОД (1961-1970 гг.).** При исследовании КРС на туберкулез выявлено 93 неблагополучных пункта, где процент реагирующих варьировало от 0,01 до 2,3 % животных. При вскрытии туберкулез обнаружен у 4806 голов крупного рогатого скота.

Таким образом, второй период характеризовался значительным ростом распространенности туберкулеза при отсутствии профилактических и остророительных мероприятий, а также нехватки ветеринарных специалистов.

**ТРЕТИЙ ПЕРИОД (1970-1980 гг.).** Он характеризуется широкомасштабным мероприятиям по борьбе с туберкулезом крупного рогатого скота.

С 1968 г. в институте расширены исследования по туберкулезу сельскохозяйственных животных, для чего была открыта специальная лаборатория по изучению этого заболевания.

Установление неблагополучия хозяйств по туберкулезу крупного рогатого скота было неравномерным. В 1968 г. было выявлено 1,1 % реагирующих из 290,7 тысяч голов первично исследованных.

К 1993 г. процент вывловленных животных снизился с 3,7 до 0,04 %. За этот период было выявлено 218 неблагополучных пунктов, оздоровлено 255 пунктов.

При анализе причин стационарного существования туберкулеза, эффективности проведенных противотуберкулезных мероприятий в неблагополучных хозяйствах республики, а также эпизоотическим обследованием установили, что основной причиной массового выявления туберкулезных животных в 1985-1995 гг. явилось отсутствие планомерной борьбы в хозяйствах, неблагополучных в предыдущие годы. За 1985-1995 гг. выявлено 49265 голов, реагирующих на туберкулин животных, из которых было сдано на мясокомбинат 48165 голов животных.

Такой масштаб распространения туберкулеза, безусловно, имел большое эпизоотологическое и эпидемиологическое значение и ориентировал ветеринарных, медицинских специалистов и руководящие органы на принятие действенных мер по борьбе с инфекцией.

Главными причинами, способствовавшими продолжительному сохранению источников инфекции и неблагополучию хозяйств, были:

- несвоевременное выявление больных животных,
- длительные перерывы между исследованиями,
- погрешности во время читки реакции,
- круглосуточное содержание животных на привязи и нарушение зоогигиенических норм и
- создание изоляторов для больных животных.

Причиной снижения количества неблагополучных пунктов в последние годы явились комиссионные обследования, которые позволили уточнить эпизоотическую обстановку в целом по республике, где наивысшая точка была найдена в 1988 г., которая составила 104 неблагополучных пункта, из 473 тысячи исследованных; выявлено 10855 голов положительно реагирующих, что составило 2,2 % из общего числа животных, подверженных исследованию. Все положительно реагирующие животные были направлены на мясокомбинат на убой без передержки в изоляторах, что явилось причиной снижения выявляемости больных туберкулезом животных в последующие годы - до 8 неблагополучных пунктов.

Кроме того, анализ статистических данных показывает тенденцию к уменьшению туш, пораженных генерализованной формой туберкулеза и направленных на утилизацию, который снизился с 13 до 2 %.

## **5 Резюме и заключение**

Как видно туберкулез по республике Таджикистан в различные периоды имеет широкое распространение.

Причиной распространения туберкулеза послужило недостаточно жесткое проведение ветеринарно-санитарных и органичительных мероприятий, неполный охват диагностическими исследованиями всего поголовья, а также не всегда правильная диагностика туберкулеза, длительная передержка больного скота со здоровым, неудовлетворительная дезинфекция животноводческих помещений, слабая квалификация ветработников и слабая кормовая база.

Эпизоотический анализ состояния дел в хозяйствах республики по туберкулезу был положен нами в основу разрабатываемых для производства предложений, систематическая и настойчивая работа позволит вначале сократить, а в дальнейшем и ликвидировать туберкулез в республике.

## **Spread of Tuberculosis in Cattle Stocks in Various Areas of Tajikistan**

D. M. Mirsojev and W. Drauschke

### **Abstract**

The publication shows that cattle stocks have severely suffered from tuberculosis in the investigated periods (1943 - 1994) in the Republic of Tadjikistan. The main causes for this situation can be seen in the insufficient implementation of

- veterinary measures,
- diagnostical control of stocks and
- long term control of suffering stocks.

Insufficient disinfection of sheds as well as poor qualification of veterinary staff and bad feeding conditions have also contributed to this situation. The implementation of these measures will contribute to diminishing and, in the future, to complete controlling tuberculosis of the cattle stocks in the Republic of Tadjikistan: carefully investigating the cattle stocks with regard to suffering from tuberculosis, strictly obeying prescriptions and recommendations and systematic and planful work of all staff responsible.

Keywords: Tajikistan, cattle, tuberculosis, spread of tuberculosis, control of tuberculosis

## Литература

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ДОНЧЕНКО А. С.; Итоги перспективы разработки и внедрения научно обоснованных борьбы с туберкулезом крупного рогатого скота // Сибирь, Вест. с.-х. науки-1990-N 2, с. 78-84.

ЯРБАЕВ Н.; Туберкулин крупного рогатого скота в республике Таджикистан // Автореферат диссертации доктора вет. наук-Новосибирск, 1983. - 38 с.

## **Buchbesprechungen**

**Schäfer, Rita;** 2003

**Gender und ländliche Entwicklung in Afrika. - Eine kommentierte Bibliographie.**

472 Seiten, Spektrum Bd. 75, Berliner Reihe zu Gesellschaft, Wirtschaft und Politik in Entwicklungsländern. 2. Aktualisierte und erweiterte Auflage. Lit Verlag, Münster, Hamburg, London, 2003, ISBN 3-8258-5053-6. Preis: br. € 30,90

Diese Bibliographie umreißt den Forschungsgegenstand der Lage der Frauen und des Verhältnisses zwischen den Geschlechtern in ländlichen Regionen Afrikas südlich der Sahara. Basierend auf Forschungsbeiträgen afrikanischer, europäischer und internationaler Forschungsinstitutionen sowie aus Fachpublikationen wird ein breit gefächertes interdisziplinäres Spektrum behandelt. Die Dokumentation umfaßt einen Zeitraum, der von den 1920er Jahren bis März 2003 reicht. Damit werden Kolonialstudien zur Frauenforschung, ebenso wie Arbeiten zeitgenössischer afrikanischer Wissenschaftlerinnen in ländlichen Gebieten Afrikas kommentiert. Überwiegend werden englisch- und deutschsprachige Arbeiten vorgestellt. Die bibliographischen Angaben reichen aus, um die Druckversionen zu bestellen. Insgesamt ist das Werk hervorragend geeignet, einschlägig interessierten Wissenschaftlern und Entwicklungsexperten eine Grundlage für die interdisziplinäre Betrachtung ihres Arbeitsgebietes zu geben.

Eckhard Baum, Witzenhausen

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**Rist, Stephan;** 2001

**Wenn wir guten Herzens sind, gibt's auch Produktion.**

**- Entwicklungsverständnis und Lebensgeschichten bolivianischer Aymarabauern: Wege bei der Erneuerung traditioneller Lebens- und Produktionsformen und deren Bedeutung für eine Nachhaltige Entwicklung.**

XXII+322 Seiten, 18 s/w Abb., 26 Tab., Sozialwissenschaftliche Schriften zur Landnutzung und ländlichen Entwicklung (Hrg. Hermann Boland, Volker Hoffmann u. Uwe Jens Nagel) Bd. 43, Margraf Verlag, Weikersheim, 2001. ISBN 3-8236-1338-3, ISSN 0947-0352. Preis: € 25,50.

Nachhaltige Entwicklung setzt Partizipation voraus, und diese wiederum, dass sich der eingeschlagene Weg in die Weltsicht der betroffenen Bevölkerung einfügt. Fünf bolivianische Bauern erzählen in diesem Buch anschaulich ihre Lebensgeschichten, deren Lektüre

allein schon äußerst eindrucksvoll ist. Nicht das Selbstverständnis der Erzähler wird deutlich, sondern auch die Einstellung zu den Mitmenschen, ihre Natursicht, und ihr Umgang mit natürlichen Ressourcen. In seiner detaillierten Analyse kommt der Autor zum Ergebnis, das es eine „andine Modernität“ gibt, die sich von der „westlich-materialistischen“ unterscheidet. Organisationen der Entwicklungszusammenarbeit sollten dies bei der Identifizierung von Entwicklungszielen berücksichtigen.

Eckhard Baum, Witzenhausen

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Schippers, R. R.; 2004

**Légumes Africains Indigènes. Présentation des espèces cultivées.**

Margraf Publishers, Weikersheim, Allemagne. 482 pages. 2004, ISBN 3-8236-1415-0. Prix: 52,- €.

Ce livre contient la description des légumes africains indigènes. Il s'agit d'une collection détaillée des légumes d'origine africaine, de ce grand continent qui n'est pas seulement la source humaine mais qui, en même temps, nous présente de nombreuses plantes, aussi des légumes. A part de très nombreuses photos qui montrent pas seulement les plantes elles-mêmes, mais aussi (et en même temps) leur spécialité concernant leur valeur nutritive, le texte nous donne des informations les plus utiles et détaillées sur les plantes maraîchères d'origine africaine.

Après une introduction (avec les thèmes: Qu'est-ce qu'un légume indigène? L'importance socio-économique des légumes indigènes. Développement et promotion des cultures. Mesures à prendre en vue de l'amélioration des ressources phytogénétiques. Principales contraintes subies par les cultivateurs souhaitant produire des légumes indigènes africains), l'auteur détaille les légumes africains selon leurs familles Amaranthaceae, Asteraceae, Brassicaceae, Caesalpiniaceae, Cucurbitaceae, Gnetaceae, Malvaceae, Papilionaceae, Pedaliaceae, Solanaceae et Tiliaceae. Après, beaucoup d'espèces mineures d'autres familles sont décrites, ainsi que les légumes africains traditionnels non indigènes.

Ce livre donne beaucoup d'informations sur l'origine et sur les aspects botaniques des espèces décrites. L'accent est mis sur les pratiques agricoles. Malgré l'intégration de nombreuses bonnes photos des cultures maraîchères traitées qui soulignent leur valeur et leur propre caractère, le prix de ce livre, qui est publié ensemble avec le CTA (Centre Technique de Coopération Agricole et Rurale) est assez bas, et le livre est accessible pour les agriculteurs, pour des étudiants de l'agriculture et de l'horticulture et pour beaucoup de personnes qui s'intéressent pour les cultures maraîchères, surtout en Afrique.

Christian Richter, Witzenhausen

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**Stoll, G.;** 2002

**Protection Naturelle des Végétaux en Zones Tropicales. Vers une Dynamique de l'Information.**

Margraf Verlag, Weikersheim, Allemagne. 368 pages. 2002, ISBN 3-8236-1356-1. Prix: 51,60 €.

Ce livre présente des informations pratiques sur les techniques de protection naturelle des végétaux dans les zones tropicales. Ces techniques, qui sont le résultat du savoir local et de la recherche scientifique, doivent toujours être testées et améliorées.

Illustré avec beaucoup de figures, les ravageurs des différentes cultures (surtout du riz, du maïs, des tubercules, des légumineuses, des plantes maraîchères, des fruits et du coton) et aussi des produits stockés sont présentés. Les méthodes de protection des végétaux contre les insectes, les nématodes, les escargots et les limaces, les rongeurs, les termites et les oiseaux sont décrites, suivi par la présentation des possibilités naturelles de protection des produits stockés, en particulier par des plantes insecticides, des poussières inertes, des substances animales, des huiles végétales et des traitements thermiques.

Dans le chapitre «Vers une dynamique de l'information» à la fin du livre, des expériences concernant des programmes de recherche avec des agriculteurs de plusieurs régions tropicales sont montrées. Ce sont de bons exemples des progrès de la protection naturelle des végétaux dans beaucoup de pays.

Ce livre du Margraf-Verlag (avec le CTA, Centre Technique de Coopération Agricole), d'un prix assez bas et d'une valeur très élevée, peut servir aux agriculteurs, aux étudiants, aux conseillers et aux chercheurs du domaine agricole, ainsi qu'à tout ceux qui s'intéressent à l'agriculture moderne. Le livre apporte une contribution notable au développement rural durable et à la promotion d'une agriculture respectueuse de l'environnement.

Christian Richter, Witzenhausen

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**Heisteringer, Andrea et al (Hrsg.);** 2004

**Handbuch Samengärtnerei.**

**Sorten erhalten. Vielfalt vermehren. Gemüse genießen.**

Unter Mitarbeit von: Verein Arche Noah, Verein Pro Specie Rara (Herausgeber), Verein Dreschflegel und Verein zur Erhaltung der Nutzpflanzenvielfalt.

Loewenzahn in der StudienVerlag Ges.m.b.H. Innsbruck, ISBN 3-7066-2352-8, 413 Seiten, durchgehend vierfarbig, viele Fotos und Zeichnungen. 39,- € je excl. Versand. Zu bestellen bei [info@arche-noah.at](mailto:info@arche-noah.at)

Reichhaltig und wunderschön illustriert, vermittelt dieses Garten- und Kochbuch zwischen den Reizen einstiger und künftiger Gaumenfreuden. Als Ergebnis einer fruchtbareren Zusammenarbeit nichtstaatlicher deutschsprachiger Kulturpflanzeninitiativen liegt nun ein Kompendium zur Erhaltung und Nutzung der Kulturpflanzenvielfalt vor, dessen sich alle diejenigen Bauern und Gärtner als Nachschlagewerk bedienen können, die sich einer dynamischen Erhaltungs- und Züchtungsarbeit eigener Haus- und Hofsorten widmen und nicht x-beliebiges Standardsaatgut aus dem Handel verwenden wollen.

Die Grundbegriffe des Gemüse-Samenbaus werden anschaulich vermittelt. Praktische Kurzanleitungen zu Reinigung, Trocknung und Lagerung von Saatgut sowie zu vorbeugenden Maßnahmen gegen Saatgutkrankheiten und Schädlinge runden die Einleitung ab.

Dann folgen in alphabetischer Reihenfolge die Pflanzenfamilien mit einer Kurzcharakteristik und mit den jeweiligen Arten. Liegt der Schwerpunkt auf der Behandlung des Gemüse-Samenbaus, so findet man wertvolle Angaben auch zu Buchweizen, Hirse, Getreide, Lein, Kartoffeln und Mohn. Arznei- und Gewürzpflanzen, Obst und technische Kulturen werden nicht explizit behandelt. Schade, daß den angegebenen botanischen Namen durchgängig die Autoren fehlen. Damit wird leider die Chance vergeben, den Bekanntheitsgrad der korrekten wissenschaftlichen Bezeichnungen zu verbessern. Es ist einfach nicht legitim, auf andere, in dieser Hinsicht ebenfalls teils unkorrekte Quellen zu verweisen.

Jemand, der sich über die ausführliche Darstellung traditioneller Kulturpflanzen mit starken regionalen Bezügen und die Erwähnung kaum mehr bekannter Volksnamen freut wird sich vielleicht daran stoßen, in dem Buch durchgängig die schon wieder auf dem Rückzug befindliche „neue“ deutsche Rechtschreibung angewendet zu finden, nach der es weder Sproß noch Stengel gibt. In den ausdrucksstarken Bildern - viele Motive kommen aus der Vermehrungspraxis des Arche-Noah-Schaugartens - und im Sprachgebrauch wie auch in der Beschreibung von Traditionen und Techniken dominieren die in (Nieder-)Österreich und Südtirol gesammelten Erfahrungen. Bei den Quellen für Saatgut und bei der Auflistung von Schaugärten im deutschsprachigen Raum fehlen daher wichtige Adressen wie auch die Darstellung der dort teilweise abweichend gehandhabten Methoden.

Trotz kleiner Mängel - und welches Druckwerk ist schon frei davon - wird dieses Buch Anfänger wie auch erfahrene Gärtner ermutigen, sich des Samenbaus anzunehmen und dabei sehr bald eigene Wege zu gehen. Es wird ihnen helfen, grobe Fehler zu vermeiden und läßt sie den schon verloren geglaubten Anschluß an eine seit Jahrtausenden praktizierte, kreative und immer wieder Überraschungen bereithaltende individuelle züchterische Tätigkeit finden. Erfahrungen und Fingerspitzengefühl, vor allem die Überwinterungsproblematik zwei- und mehrjähriger Sippen, die Bestandsgrößen sowie die Isolierabstände betreffend, können nur durch gärtnerische Praxis erworben werden. Mit dem geeigneten Ausgangssaatgut, dem Wissen und dem Handwerkszeug ausgestattet, wird jedem Nutzer aber hoffentlich schnell klar, daß es eigentlich gar nicht so schwer ist, zur Erhaltung und Vermehrung von Haus- und Hofsorten beizutragen, daß es durchaus populär ist und obendrein Freude bereiten kann, von dem eigenen, reichlich geernteten

Saatgut Nachbarn, Freunden und Bekannten abzugeben. Diese echte Freude, einer der wenigen nun wirklich nicht kommerzialisierbaren Bereiche, stellt sich spätestens dann ein, wenn man mit Fremden über den Gartenzaun hinweg ins Gespräch kommt, weitere Anregungen erhält und Erfahrungen austauscht - aber auch Saatgut und Pflanzen.

Thomas Gladis, Bonn und Witzenhausen

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**Reinhard Heller; 2002**

**Grünes Gold der Altmark**

**Erinnerungen an die erloschene norddeutsche Hopfenbautradition**

99 Seiten, 80 überwiegend farbige Abbildungen Offset-Druck und Verlag Clemens Köhler, Harsum, 2002, Preis:17,- €

In der Geschichte Norddeutschlands hat der Hopfenanbau über Jahrhunderte eine herausragende wirtschaftliche Bedeutung gehabt, zu Beginn des 20. Jahrhunderts wurde der Hopfenanbau dann aufgegeben. Der Hopfen hat für das Bier nicht nur eine geschmacksrelevante Seite, sondern er macht auch das Bier haltbarer. Das Bierbrauen war ursprünglich eine hauswirtschaftliche Notwendigkeit, sowie es auch heute noch in einigen Ländern der Tropen und Subtropen der Hausfrau obliegt, den sogenannten Hastrunk herzustellen. Erst durch die Hopfung des Bieres wurde der Fernhandel möglich. Aus dem Inhalt:  
Der Weinstock des Nordens,

Die Stadt Gardelegen als Zentrum des altmärkischen Hopfenbaues und Hopfenhandels aus den Erfahrungen eines Hopfenbaupraktikers,

Der Niedergang der Hopfenkultur - Gründe und Folgen,

Hastrunkbereitung und Geschichte des lokalen Braugewerbes.

Ein informatives und lesenswertes Buch, das auch den Blick frei gibt für grundlegende Veränderungen einer Kulturlandschaft und sensibilisiert für gegenwärtigen Veränderungen, lokal und global.

Hans Hemann, Witzenhausen

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## **International Training Programme**

### **Quality Management, Certification and Marketing of Organically Produced Agricultural Commodities**

Conducted by:

German Institute for Tropical and Subtropical Agriculture and  
Department of Organic Food Quality and Food Culture, Faculty of Organic Agricultural  
Sciences, University of Kassel, Witzenhausen

#### **Background and Current Constraints**

Organically produced agricultural commodities from developing countries offer opportunities for producers affecting generation of farm level income and export earnings. Markets exist in the European Union, the USA and Japan if the particular prerequisites regarding ecological and social standards are met (e.g. Regulations on "Organic Production of Agricultural Products", No. 2092/91, for the EU). However, many developing countries perceive these regulations as non-tariff trade barriers, in particular when relevant information and knowledge on production, processing and marketing is lacking.

Whenever organic products are being exported, quality management as well as inspection and certification is required and carried out by internationally operating certification firms, generally headquartered in the importing countries. This procedure involves high costs, which can hardly be met by small-scale producers. Therefore, many developing countries thrive to acquire relevant know-how on quality management, and to develop local structures, quite often in co-operation with importing firms from industrialised countries.

#### **Target Group**

The programme is designed for professionals and multipliers who are directly or indirectly involved in production, processing and marketing, particularly in the field of organic agriculture, irrespective whether they are self-employed or agents of producer organisations, processing industries, trading firms, donor agencies or staff members of educational institutions. Participants are expected to hold a B.Sc. agric. or equivalent.

#### **Programme Purpose**

Participants are acquainted with relevant standards and regulations on organic production of agricultural commodities. They are able to develop local structures and apply appropriate methods of quality control and certification.

Further information under:

<http://www.ditsl.de>

## **Notes to authors**

The Journal of Agriculture in the Tropics and Subtropics publishes papers and short communications dealing with original research in the fields of rural economy and farm management, plant production, soil science, animal nutrition and animal husbandry, veterinary hygiene and protection against epidemics, forestry and forest economy.

The sole responsibility for the contents rests with the author. The papers must not have been submitted elsewhere for publication. If accepted, they may not be published elsewhere without the permission of the editors.

Manuscripts are accepted in German, English, French, and Spanish. Papers may not be published in the order of receipt, those that require minor amendments, only are likely to appear earlier. Authors are advised to retain one copy of the manuscript themselves as the editors cannot accept any responsibility for damage or loss of manuscripts.

### *1. Contents of the manuscripts*

Findings should be presented as brief as possible. Publication of a paper in consecutive parts will be considered in exceptional cases.

The following set-up is recommended:

The introduction should be as brief as possible and should concentrate on the main topics of the paper. Reference should be made to recent and important literature on the subject, only.

Materials used and methods applied should be explained briefly. Well-known or established methods and procedures should not be described. New or important methods should be explained. With all its brevity, this part should enable the reader to assess the findings adequately.

Tables and Figures should be used to effectively present the results. Explanations and other remarks on the results can be included in the text.

Discussion of results should also refer to relevant literature on the topic and lead to clear conclusions. Recommendations with respect to further research needed on the respective subject will increase the value of the paper.

The summary should concentrate on the main results and conclusions to highlight the author's contribution. It should be suitable for information storage and retrieval.

### *2. Form of the manuscripts*

Manuscripts should be typed double-spaced with a wide margin, preferable on disk.

The documents should be prepared with standard software (Microsoft Word, Word Perfect,  $\text{\LaTeX}$ ). Alternatively, the manuscript can be submitted as a simple text/rtf file together with a printed version of the original format.

Please do not use automated or manual hyphenation.

Title, headings and references (names of authors) should not be in capitals.

Tables and figures should be attached at the end of the document or separately. The preferred position for the insertion of tables and figures should be marked on the margin of the text.

The manuscript should not be longer than 15 typed pages including tables, figures and references.

The title of the paper is followed by the name(s) and address(es) of the author(s).

The abstract should be followed by a list of keywords (up to eight).

For each paper, a summary must be submitted in the same language (not more than 20 lines) and in English, if the paper is written in an other language.

Tables should not be prepared with blanks and should fit on a DIN A5 page (max. width: 12cm (landscape: 18.5cm) with a minimum font-size of 7pt. ).

All tables should have captions and should be numbered consecutively.

Figures should be black&white/greyscaled and suitable for reproduction (if possible, vector formats, postscript .ps .eps). Photos should be high-gloss prints of good contrast, maximum size 13 by 18 cm, line drawings with Chinese ink on white or transparent paper. All figures should be numbered consecutively. A separate list of captions for illustrations has to be added.

S.I. (System International) units have to be used throughout.

References in the text should be made by the name of the author and the year.

Each paper should have an alphabetical list of references giving name and abbreviated first name of the author(s), title of the paper, name of the journal, number of the volume, year, page numbers; for books: title, place of publication, and year.

On publication, each author will receive two copy of the Journal

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Editorial Board

Steinstrasse 19,D-37213 Witzenhausen

E-mail: tropen@wiz.uni-kassel.de , Fax (0) 5542 981313

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