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Quo vadis Süßwasser ?
Anmerkungen zum „Internationalen Jahr des Süßwassers 2003“

Quo vadis freshwater ?
Remarks on the “International Year of Freshwater 2003”

P. Wolff [1]

Abstract
The United Nations General Assembly proclaimed in a resolution in 2002 the “International Year of Freshwater 2003”. The aim of the year is to raise awareness of the importance of protecting and managing freshwater resources in a sustainable way. On occasion of the International Year of Freshwater the author highlights the competing demands and gives a short description of three scenarios of fresh water use. From these scenarios it can be concluded that only the establishment of a sustainable, integrated water management will avoid a water crisis and maintain food security.

Keywords: International Year of Freshwater 2003, competing freshwater demands, scenarios of fresh water use, water crisis, sustainable water use
Stichworte: Internationales Jahr des Süßwassers 2003, konkurrierende Nachfrage nach Süßwasser, Szenarien der Süßwassernutzung, Wasserkrise, nachhaltige Wassernutzung

1 Einführung

Die Vollversammlung der Vereinten Nationen hat das Jahr 2003 zum „Internationalen Jahr des Süßwassers“ erklärt. Im Verlauf des Jahres 2003 sollen nach den Vorstellungen der UNO Wege aufgezeigt werden, wie den globalen Wasserproblemen wirkungsvoll begegnet werden kann. Die UNO möchte mit dieser Aktivität eine internationale Plattform schaffen, die dazu dienen soll, geeignete Initiativen für eine nachhaltige Bewirtschaftung der Süßwasserressourcen zu entwickeln und voran zu bringen. Mit dieser Aktivität sollen zugleich die Ziele weiter verfolgt werden, die anlässlich des World Summit on Sustainable Development in Johannesburg (Südafrika) im August 2002 in bezug auf die Wasserversorgung festgeschrieben wurden: (a) Halbierung des Anteils der Weltbevölkerung, der bisher nicht in der Lage war, sich Zugang zu einer gesicherten Trinkwasserversorgung zu verschaffen, bzw. sich eine solche nicht leisten konnte; (b) der nicht nachhaltigen Erschließung von Wasserressourcen Einhalt zu gebieten. Die Mitgliedsstaaten der UNO und Nichtregierungsorganisationen sollen veranlasst werden, mit eigenen Beiträgen und Aufklärungskampagnen für einen umsichtigen Umgang mit der lebensnotwendigen Ressource Wasser zu werben. Die UNESCO hat die Federführung für das Jahr des Süßwas-

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sers 2003 übernommen (Deutsche UNESCO-Kommission, 2002). Der Generaldirektor der UNESCO Koichiro Matsuura brachte aus Anlass der Eröffnungszeremonie des Internationalen Jahres des Süßwassers am 12. Dezember 2002 in den Vereinten Nationen in New York u.a. zum Ausdruck, dass

> water can be an agent of peace, rather than conflicts, and UNESCO is looking at ways that will allow this century to be one of "water peace" rather than "water wars". By developing principles and methods to manage this resource efficiently and ethically, while respecting related ecosytems, we move a step closer to the goal of sustainable development.

Nachfolgend soll die konkurrierende Nachfrage nach Süßwasser kurz skizziert werden, die wichtigsten Entwicklungsalternativen des Umganges mit den Süßwasserressourcen aufgezeigt und die sich daraus ergebenden Konsequenzen und Auswirkungen auf die globale Entwicklung diskutiert werden.

2 Konkurrierende Nachfrage nach Süßwasser

Die Deutsche UNESCO-Kommission (2002) hat zum Auftakt des Internationalen Jahres des Süßwassers 2003 deutlich gemacht, dass Süßwasser eines der bedeutendsten Elemente für das Leben auf der Erde ist. Es ist unersetzbar für die Nahrungsmittelerzeugung und als Energiequelle. Sauberes Wasser ist Voraussetzung für das Funktionieren der Ökosysteme und für die Gesundheit des Menschen. Aber die Wasservorräte sind begrenzt und zudem ungleich verteilt. 70 Prozent der Erdoberfläche sind mit Wasser bedeckt, doch nur 2,5 Prozent der Wasservorräte der Erde insgesamt sind Süßwasservorkommen. Während nach Aussage der Deutsche UNESCO-Kommission (2002) in den reichen Industrieländern Wasser verschwendet wird, bringt das Bevölkerungswachstum in den trockenen Gebieten der Erde - im Nahen Osten, in Nordafrika und Südasien - akute Wasserknappheit mit sich. Dieser Aussage ist entgegen zu halten, dass Wasserverschwendung nicht generell auf reiche Industrieländer beschränkt ist. Im Gegenteil, in vielen Industrieländern wird mit den Wasserressourcen deutlich sparsamer umgegangen als in Entwicklungsländern. Ferner ist die akute Wasserknappheit in den trockenen Gebieten der Erde nicht eine zwangsläufige Folge des Bevölkerungswachstums. Sie ist vielmehr nur zu oft die Folge einer fehlgeleiteten Wasserpolitik, der Fehlallokation in der Bewirtschaftung bzw. der Nutzung der Wasserressourcen. Hinzu kommt das weitverbreitete Missmanagements bei der Wasserbereitstellung. Das Problem lässt sich nicht auf die Schlagworte Wasserverschwendung, Bevölkerungswachstum und Wasserknappheit reduzieren. Es ist äußerst vielschichtig und entzieht sich in der Regel einer pauschalen Beurteilung, jeder Einzelfall, jedes Land, jede Region bedarf einer differenzierten Betrachtung. Mit der Verknappung der Wasserressourcen ist allerdings allgemein eine zunehmende Konkurrenz um das Süßwasser, die Süßwasserressourcen zu beobachten ist. Nicht nur Länder streiten um grenzüberschreitende Süßwasservorkommen, auch die Wassernutzungssektoren treten innerhalb ihres Einzugsgebietes in Konkurrenz untereinander.

2.1 Häusliche Wassernutzung

Gegenwärtig werden ca. 250 km^3 Süßwasser pro Jahr für häusliche Zwecke verwendet, Tendenz steigend. 1,1 Milliarden Menschen, etwa ein Sechstel der Weltbevölkerung, haben laut UNESCO keinen Zugang zu sauberem Wasser. 40 Prozent der Weltbevölkerung verfügen über keine adäquate Abwasserentsorgung. Täglich sterben ca. 6.000 Kinder an Krankheiten, deren Ursache direkt oder indirekt durch unsauberes Wasser ist. Etwa 80 Prozent aller Krankheiten in Entwicklungsländern werden auf verschmutztes Trinkwasser und mangelhafte Abwasserentsorgung zurückgeführt. Nach Schätzungen der UNESCO (2002) sterben weltweit jährlich über 5 Mio. Menschen an Krankheiten, die mit Wasser in Beziehung stehen. Ca. 2,3 Mrd. Menschen leiden unter Krankheiten, die ihre Ursache in verschmutztem Wasser haben. Angesichts der oben kurz skizzierten Problematik ist verständlich, dass der Nutzung der Süßwasserressourcen zur Sicherung der kommunalen bzw. häuslichen Wasserversorgung meist politisch erste Priorität eingeräumt wird. Die häusliche Wasserversorgung konkurriert mit den anderen Nutzungen vor allem um die qualitativ hochwertigen Süßwasserressourcen. Sie hat dabei den Vorteil, dass sie unter normalen wirtschaftlichen Verhältnissen ein höheres Preisniveau hat als die anderen Süßwassernutzer. Sie kann damit im Regelfall höhere Aufwendungen für die Nutzung der Süßwasserressourcen tätigen und hat folglich einen erleichterten Zugriff auf die Süßwasserressourcen.

2.2 Landwirtschaftliche Wassernutzung

Die weltweiten Wasserprobleme reduzieren sich allerdings nicht allein auf die Sicherstellung der Versorgung der Bevölkerung mit Trinkwasser in ausreichender Menge und in hinreichender Qualität. Um die Süßwasserressourcen konkurrieren neben der häuslichen Nutzung, die landwirtschaftliche Nutzung, die industrielle und gewerbliche Nutzung. Hinzu kommen die Ansprüche des Natur- und Umweltschutzes. Ein wesentliches Problem der Konkurrenz um die Süßwasserressourcen stellt die Tatsache dar, dass die Landwirtschaft fast 70% aller derzeit erschlossenen Süßwasserressourcen nutzt, vorzugsweise zum Zwecke der Bewässerung. Verbunden ist dies nur zu oft mit der Übernutzung von Grundwasservorkommen. Man schätzt, dass die Grundwasserentnahme, vor allem durch die Landwirtschaft, die Grundwassererneuerung weltweit um 160 Mrd. Kubikmeter pro Jahr übersteigt. Dies entspricht der doppelten jährlichen Abflussmenge des Nil. Sinkende Grundwasserstände bis hin zur Erschöpfung von Grundwasservorkommen sind die Folge dieser Überbeanspruchung. Wenn man bedenkt, dass viele der wichtigen Getreideanbaugebiete der Welt auf der Nutzung von Grundwasservorkommen basieren wird deutlich, welch unsichere Basis die Ernährung der Weltbevölkerung besitzt.

Der enorme Wasserbedarf der Landwirtschaft resultiert der aus der Tatsache, dass die Pflanzen relativ große Wassermengen für die Produktion benötigen. Die Erzeugung von 1 kg Reis z.B. erfordert 1.000 bis 3.000 Liter Wasser. Um 1 Tonne Getreide zu erzeugen sind ca. 1.000 Tonnen Wasser nötig. Das Problem „Landwirtschaft und Nutzung der Süßwasserressourcen“ wird verschärft durch das weitverbreitete unzureichende Wassermanagement im Farmbereich, insbesondere der unbefriedigenden Be- und Entwässerungspraktiken. Vernässung und Versalzung der Ackerflächen sind nur zu oft

die Folge. Es wird geschätzt, dass heute etwa 10% der 225 Mio. ha umfassenden Weltbewässerungsfläche von der Bodenversalzung betroffen sind. Weitere 80 Mio. ha werden durch die Kombination von Bodenversalzung und Bodenvernässung negativ beeinflusst. Managementprobleme im Farmbereich werden darüber hinaus verantwortlich gemacht für die Befrachtung der Wasservorkommen mit Schadstoffen.

Der große Anteil der Landwirtschaft an der Nutzung der erschlossenen Süßwasserressourcen hat in jüngster Zeit zu einer z.T. recht kontroversen Debatte geführt. Agrarwissenschaftler haben deutlich gemacht, dass der Wasserverbrauch der Landwirtschaft, insbesondere der Bewässerungslandwirtschaft, weiter zunehmen muss, um die Nahrungsmittelversorgung zu sichern, den Hunger und die Armut der schnell wachsenden Weltbevölkerung in den nächsten 25 Jahren deutlich zu reduzieren. Demgegenüber haben Wissenschaftler des Bereiches Umwelt- und Naturschutz gefordert, dass der Wasserverbrauch mindestens um 10% vermindert werden muss. Dies vor allem um Fließgewässer, Seen und Feuchtbiotope in ihrer Funktion zu erhalten. Aber auch um die Lebensgrundlage der Menschen zu sichern, die ihren Lebensunterhalt durch die Nutzung der Gewässer bestreiten. Der Konflikt „Wasser für Nahrungsmittel oder Wasser für die Umwelt“ bedarf dringend eines intensiven Dialogs (RIJSBERMAN, 2001).

2.3 Industrielle Wassernutzung

Gegenüber der Landwirtschaft ist die Wassernutzung der Industrie weltweit mit ca. 22% der erschlossenen Wasservorkommen relativ bescheiden. Dabei gibt es gravierende Unterschiede zwischen der Industrie in den Ländern mit hohen Einkommen (Wasserverbrauch der Industrie ca. 58%) und der Industrie in Ländern mit niedrigen Einkommen (industrieller Wasserverbrauch ca. 8% der erschlossenen Wasservorkommen). Experten rechnen allerdings mit einem starken Anstieg des Wasserverbrauch der Industrie bis 2025, und zwar von 752 km^3/Jahr in 1995 auf 1.170 km^3/Jahr im Jahr 2025 (UNESCO, 2002). Von dem seitens der Industrie entnommenen Wasser wird ein Großteil wieder in flüssiger Form dem Wasserkreislauf zugeführt. Allerdings ist dieses Wasser zum Teil stark mit toxischen Chemikalien und Metallen befrachtet. Die UNESCO (2002) schätzt, dass die Wasservorkommen seitens der Industrie jährlich mit 300 - 500 Mio. Tonnen Schwermetallen, verschiedenster Lösungen, toxischen Schlämmen und anderen Abfällen befrachtet werden. Zur Befrachtung der Wasservorkommen mit organischen Abfallstoffen trägt die Nahrungsmittelindustrie in erheblichem Umfang bei. Die Industrie konkurriert mit den anderen Nutzungen nicht nur in quantitativer, sondern vor allem in qualitativer Hinsicht. Viele Industriezweige sind auf Süßwasser von hoher Qualität angewiesen.

2.4 Wassernutzung zur Energiegewinnung

Bei der Betrachtung der Wassernutzung darf die Energiegewinnung durch Wasserkraft nicht außer acht gelassen werden. Immerhin werden heute ca. 19% der weltweit produzierten elektrischen Energie mit Hilfe von Wasserkraft erzeugt, mit Schwerpunkten in Kanada, den USA und Brasilien. Die Energieerzeugung erfolgt mit Hilfe von Staudämmen. Heute sind weltweit ca. 45.000 größere Staudämme mit entsprechenden Stromerzeugungsanlagen in Betrieb. Die Staudämme sind meist Multifunktionsanlagen, sie dienen

neben der Erzeugung elektrischer Energie, der Bereitstellung von Bewässerungswasser und der Abflussregulierung (Hochwasserschutz, Schifffahrt, Freizeit und Erholung etc.). Die Staudämme liefern in der Regel preiswerte elektrische Energie und tragen durch die Bereitstellung von Bewässerungswasser zur Nahrungsmittelerzeugung bei. Etwa 16% der Nahrungsmittel werden weltweit mit Wasser aus Stauseen erzeugt. Der Energiegewinnung mit Hilfe der Wasserkraft werden zudem positive Umweltwirkungen zugesprochen, weil dabei keine Treibhausgase anfallen. Die Dämme und die durch sie gebildeten Stauseen beeinflussen andererseits aber auch die Umweltverhältnisse, sowie das hydrologische Geschehen oberhalb wie auch unterhalb des jeweiligen Dammes. Negativen Wirkungen sind für die Lebensbedingungen von Flora und Fauna innerhalb und im Umfeld der Gewässer zu erwarten. Auch sind negative Wirkungen auf die Lebensumwelt der örtlichen Bevölkerung nicht auszuschließen. Die UNESCO (2002) schätzt, dass durch die Stauseen über 400.000 km^2 meist hochproduktives Land überflutet und der landwirtschaftlichen und forstlichen Nutzung entzogen wurde. Zwischen 40 und 80 Mio. Menschen haben durch die Dämme ihre Heimat verloren. Verlust von Wäldern und Lebensraum von Wild sowie die Verarmung aquatischer Biodiversität sind vor allem Folgen großer Staudämme und Stauseen.

Die Nutzer des Wassers der Stauseen befinden sich oft in einem Konkurrenzkampf. Dabei geht es um die Allokation des Wassers, d.h., wer darf wie viel des gestauten Wassers in welchem Zeitraum, zu welchem Zeitpunkt nutzen. Das Problem entsteht z.B. dadurch, dass der Wasserbedarf der einzelnen Nutzer zeitlich nicht deckungsgleich ist.

2.5 Natur und Umweltschutz

Ein weiteres Problem stellen die Gefahren dar, denen die Süßwasservorkommen und die mit ihnen in Zusammenhang stehenden Landschaften durch menschliche Aktivitäten ausgesetzt sind. Dies vor allem als Folge einer nicht nachhaltigen Entwicklung, der Übernutzung und des Missbrauchs der begrenzten Süßwasserressourcen. Nach Schätzungen der UNESCO (2002) sind über die Hälfte der größeren Flüsse stark verschmutzt oder trocknen im Bereich ihres Unterlaufes infolge Übernutzung periodisch oder dauerhaft aus. Es wird geschätzt, dass die Fließgewässer jährlich mit gut 2 Mio. t Abfällen aus menschlichen Aktivitäten befrachtet werden. Neben den Fließgewässern sind vor allem die stehenden Gewässer, die Seen von negativen Einflüssen menschlichen Handelns betroffen. Aber auch das Grundwasser wird zunehmend durch Befrachtung mit Schadstoffen negativ beeinflusst. Verschmutzung und Übernutzung der Wasservorkommen haben den Strom der Umweltflüchtlinge in zweistellige Millionenhöhe anwachsen lassen.

Besonders stark betroffen von den menschlichen Eingriffen in die Ökosysteme sind die Feuchtgebiete. Nach dem internationalen Feuchtgebiets-Übereinkommen (Ramsar-Konvention) von 1971 sind Feuchtgebiete Feuchtwiesen, Moor- und Sumpfgebiete oder Gewässer, die natürlich oder künstlich, dauernd oder zeitweilig, stehend oder fließend, von Süß-, Brack- oder Salzwasser beherrscht werden, einschließlich solcher Meeresgebiete, die eine Tiefe von 6 m bei Niedrigwasser nicht übersteigen. Nach Schätzungen der UNESCO (2002) sind die Hälfte der Feuchtgebiete der Welt zwischenzeitlich verlorengegangen, die meisten in den letzten 50 Jahren. Da die Feuchtgebiete in der Regel

eine reichhaltige Flora und Fauna besitzen, bedeutet deren Verlust zugleich auch eine Einschränkung an Biodiversität, den Verlust von Arten. Zur Erhaltung und Rückgewinnung von Feuchtgebieten wird von Seiten des Natur- und Umweltschutzes die Allokation und Reallokation von Süßwasserressourcen für diese Zwecke gefordert. Dadurch tritt zwangsläufig eine Konkurrenz zu den anderen Wassernutzungen ein.

Klimatische Einflüsse haben schon immer, besonders aber in den letzten Jahrzehnten, zu Dürre- und zu Flutkatastrophen geführt. Wie weit die jüngste Häufung dieser Katastrophen auf natürliche Klimaschwankungen, auf vermutete globale Klimaänderungen oder auf die Veränderungen der lokalen, regionalen Umweltverhältnisse zurückzuführen sind, bedarf noch der Klärung. Erwiesen ist, dass der Mensch in den letzten Jahrzehnten immer mehr, immer weiter massiv in ökologisch, wasserwirtschaftlich sensible Gebiete vorgedrungen ist. Und dass er mit seinen Aktivitäten die herrschenden labilen Gleichgewichtszustände der Natur nachhaltig gestört hat. Dürre- und Flutkatastrophen und vor allem deren Auswirkungen lassen erkennen, dass die hydrologischen Systeme in Unordnung geraten sind.

Die aufgezeigten Konkurrenzsituationen einzeln und in ihrer Gesamtheit machen deutlich, dass die Süßwasserressourcen sich weltweit in einer argen Bedrängnis befinden. Sie zeigen aber auch, dass Strategien und Aktivitäten zur Abwendung der sich ankündigenden Wasserkrise notwendig sind. Die zu entwickelnden Strategien und deren Umsetzung werden holistische Ansätze verfolgen müssen, wenn sie sich als nachhaltig erweisen sollen. Die nachhaltige Sicherung der Nahrungsmittelversorgung wird dabei eine herausragende Rolle spielen. Dies vor allem, weil man erkannt hat, dass für die Frage, ob es möglich ist 8 Mrd. oder gar 10 Mrd. Menschen auf der Erde zu ernähren, vor allem die Ressource Süßwasser als der begrenzte Faktor anzusehen ist.

3 Alternativen

Das Internationale Food Policy Research Institute (IFPRI) und das International Water Management Institute (IWMI) sind jüngst der Frage nachgegangen, wie sich die Wasserpolitik und Investitionsentscheidungen auf die Nutzung der Süßwasserressourcen und die Nahrungsmittelerzeugung auswirken. Dabei wurde ein von IFPRI entwickeltes globales Modell der Wasser- und Nahrungsmittelversorgung und der künftigen Nachfrage zum Studium verschiedener globaler Szenarien benutzt. Am Beispiel von drei dieser Szenarien sollen die möglichen Alternativen der künftigen Süßwassernutzung und deren Auswirkungen aufgezeigt werden. Die Szenarien können hier allerdings nur kurz skizziert werden. Eine detailierte Darstellung findet sich in den Publikationen des IFPRI (Rosegrant *et al.*, 2002b,a).

3.1 „Business as usual“ Szenario

Bei dem ersten, dem „Business as usual“ Szenario wurde davon ausgegangen, dass die bisherige Wasser- und Ernährungspolitik, das Management und die Höhe der Investitionen im Wassersektor bis 2025 unverändert bleiben. Ferner wurde von der Annahme ausgegangen, dass die internationalen Geldgeber wie auch die nationalen Regierungen ihre Investitionen im Agrar- und Bewässerungssektor weiter reduzieren werden. Darüber

hinaus wurde davon ausgegangen, dass sowohl die Regierungen wie auch die Wassernutzer selbst künftig die notwendigen institutionellen Reformen und die Verbesserung des Managements im Wassersektor nur halbherzig und partiell angehen.

Die Studien ergaben u.a.: Unter den oben skizzierten Bedingungen wird der Wasserverbrauch seitens der Haushalte, der Industrie und der Viehwirtschaft von 1995 bis 2025 um 62% steigen, ausgenommen davon ist der Bewässerungssektor. Die Wassernutzung durch die Industrie wird in den Entwicklungsländern deutlich schneller steigen als in den Industrieländern. Allerdings werden geringe Erhöhungen der Preise für das durch die Industrie genutzte Wasser, verbesserte Gesetze und Verordnungen, Kontrolle der Wasserverschmutzung und der Durchsetzung der Gewässerreinhaltung, wassersparende Technologien etc. zu Effizienzsteigerungen in der Wassernutzung seitens beitragen. Die Nachfrage nach Wasser wird bei den Haushalten in dem obigen Zeitraum gleichfalls steigen, vor allem in den Entwicklungsländern. Die Ursache hierfür werden in der Urbanisierung, den Einkommenssteigerungen und dem Bevölkerungswachstum gesehen. Obwohl Verbesserungen in der Wasserbereitstellung und eine Zunahme der Hausanschlüsse erwartet werden, bleibt doch ein großer Anteil der Haushalte in den Entwicklungsländern ohne Hausanschlüsse und wird im Vergleich zu den Haushalten mit Hausanschlüssen mit weniger Wasser unzureichender Qualität auskommen müssen. Trotz der Anstrengungen von Umweltschützern und anderen Interessengruppen, wird die Konkurrenz um die Nutzung der Wasserressourcen dazu führen, dass der Anteil der Süßwasserressourcen, der für Zwecke des Umwelt- und Naturschutzes bereitsteht, nicht zunimmt.

Die Landwirte werden in 2025 aktuell nur etwa 4% mehr Bewässerungswasser verbrauchen können als in 1995. Die potentielle Nachfrage liegt mit 12% deutlich höher. Ursache für diese Diskrepanz ist der Mangel an verfügbarem Wasser. Dies wird zu einem geringeren Wachstum der Nahrungsmittelerzeugung führen und in einer substantiellen Verlagerung der Produktionsstandorte. Bei Wassermangels werden die Landwirte nicht in der Lage sein, die Erträge der Nahrungsmittelkulturen so schnell zu steigern, wie dies in der jüngeren Vergangenheit der Fall war. Bis zum Jahr 2025 wird die Getreideproduktion auf bewässerten Flächen aufgrund des Wassermangels um 300 Mio. Tonnen pro Jahr geringer ausfallen. Diese Differenz ist annähernd so groß wie die Getreideerzeugung der USA im Jahr 2000.

Angesichts des steigenden Nahrungsmittelbedarfs und einer Verlangsamung des Produktionszuwachses werden die Entwicklungsländer gezwungen sein, ihren Nahrungsmittelbedarf in zunehmendem Umfang über Importe zu decken. Einige Länder werden diese Importe aus den Überschüssen finanzieren, die das wirtschaftliche Wachstum der nichtlandwirtschaftlichen Sektoren erbringt. Wenn jedoch dem erhöhten Importbedarf an Nahrungsmitteln nur ein geringes wirtschaftliches Wachstum gegenüber steht, werden diese Länder nicht in der Lage sein, in dem erforderlichen Umfang Nahrungsmittel zu importieren. Sie werden die Sicherung der Nahrungsmittelversorgung kaum noch gewährleisten können. Viele afrikanische Länder südlich der Sahara und die nicht Erdöl produzierenden Länder des Nahen Osten sowie die Länder Nordafrikas werden von dieser Situation besonders stark betroffen sein.

3.2 Szenario Wasserkrise

Die IFPRI/IWMI Studie hat sehr deutlich gezeigt, dass mit einer echten Wasserkrise gerechnet werden muss, wenn sich die gewärtigen Trends in der Wasser-, Agrar- und Ernährungspolitik sowie bei den Investitionen verschlechtern, selbst wenn dies nur in einer relativ gemäßigten Form geschieht. Einem solchen Szenario liegt als Annahme zugrunde, dass die Regierungen ihre Ausgaben für den Bewässerungssektor kürzen werden und den Transfer der Bewässersysteme von der staatlichen Administration an die Wassernutzer oder Wassernutzergruppen beschleunigen ohne die notwendigen Reformen (Wasserrecht etc.) durchzuführen. Die negativen Wirkungen auf die Ernährungssituation wird noch verschärft, wenn die Regierungen und die internationalen Geldgeber ihre Investitionen in die Förderung der Pflanzenzüchtung, insbesondere für den Bereich des Regenfeldbaues und die Erzeugung von Grundnahrungsmitteln in Entwicklungsländern verringern.

Bei diesem Szenario wird der weltweite Wasserverbrauch bis zum Jahr 2025 um 261 km^3 über dem Verbrauch des erstgenannten Szenarios liegen, d.h. eine Steigerung um 13%. Große Anteile dieses zusätzlichen „Verbrauchs“ stellen Verluste dar. Praktisch wird der zusätzliche Verbrauch zum überwiegenden Teil für Bewässerungszwecke genutzt werden. Dies vor allem, weil die Landwirte das Wasser weniger effizient nutzen und zum Ausgleich für die Verluste mehr Wasser dem Wasserdargebot entnehmen werden. In dem Bemühen ihren Wasserbedarf zu befriedigen, werden die Landwirte, wo immer möglich, in zunehmendem Umfang Grundwasser nutzen und schließlich in großem Umfang übernutzen. Und zwar wesentlich mehr als dies heute schon der Fall ist. Die Folge sind sinkende Grundwasserstände bis hin zur Erschöpfung der Grundwasservorkommen. Es ist darüber hinaus zu befürchten, dass in zunehmendem Umfang Wasserressourcen in Anspruch genommen werden, die für die Erhaltung von Feuchtbiotopen und die Lebensfähigkeit von aquatischen Ökosystemen unerlässlich sind. Hinzu kommt, dass durch eine unzureichende Gestaltung des Wasserpreises und eine unbefriedigende Reform der Regulierungsinstrumentarien sowie der nur zögerlichen Annahme von verbesserten Technologien, die Wassernachfrage der Industrie in 2025 um 33% über der Nachfrage des Szenarios „Business as usual“ liegen wird. Und dies ohne ein Mehr an industrieller Produktion. Ferner führt die Zunahme der städtischen Bevölkerung zu einem schnellen Anstieg des häuslichen Wasserbedarfs. Ohne grundlegende Reformen im Wassersektor, insbesondere hinsichtlich der Preisgestaltung, werden die Regierungen aufgrund fehlender Finanzmittel nicht in der Lage sein, das Versorgungs- und Entsorgungsnetz dem Zuwachs der Bevölkerung entsprechend auszubauen.

Ein solches Szenario hat logischerweise u.a. Konsequenzen für die Nahrungsmittelerzeugung. Insgesamt werden die Landwirte in 2025 ca. 10% weniger Nahrungsmittel produzieren als unter den Bedingungen des Szenarios „Business as usual“. Ursache hierfür sind der Rückgang der kultivierten Landfläche und der Erträge. Dieser Rückgang entspricht der jährlichen Getreideernte Indiens. Diese Veränderungen in der Nahrungsmittelproduktion dürften zu einem starken Anstieg der Nahrungsmittelpreise führen. Rosegrant *et al.* (2002a,b) geht davon aus, dass die Preise für Reis um 40%, von Weizen um 80% und von Mais um 120% unter den Bedingungen einer Wasserkrise steigen werden. Ferner wird davon ausgegangen, dass die höheren Nahrungsmittelpreise zu einem Rückgang im

Handel mit Nahrungsmitteln führen werden. Die Entwicklungsländer werden ca. 58 Mio. Tonnen Getreide weniger einführen als unter den Bedingungen des Szenarios „Business as usual“, ein Rückgang um 23%. Das entscheidende Ergebnis des Szenarios „Wasserkrise“ ist, dass mit einer wachsenden Unsicherheit in der Nahrungsmittelversorgung zu rechnen ist, wenn dieses Szenario Realität werden sollte. Der Getreidekonsum pro Kopf der Bevölkerung der Entwicklungsländer würde in 2025 unter dem entsprechenden Verbrauch im Jahr 1995 liegen.

3.3 Szenario nachhaltige Wassernutzung

Glücklicherweise ist, trotz der dramatischen Entwicklung innerhalb des Wassersektors, ein Szenario einer nachhaltigen Wassernutzung noch immer vorstellbar. Die von IFPRI und IWMI durchgeführten Studien haben dies bestätigt (ROSEGRANT *et al.*, 2002b). Danach ist es durchaus möglich die Allokation von Süßwasser für Zwecke des Natur- und Umweltschutzes deutlich zu erhöhen, alle städtischen Haushalte mit Hausanschlüssen auszustatten und eine Erhöhung des Wasserverbrauchs pro Kopf der Bevölkerung auf ein hygienisch erforderliches Niveau zu ermöglichen und dabei gleichzeitig die Nahrungsmittelerzeugung auf dem Niveau zu halten, wie sie unter dem „Business as usual“ Szenario unter 3.1 beschrieben wurde.

Das Szenario der nachhaltigen Wassernutzung geht allerdings davon aus, dass die Regierungen, wie auch die internationale Gebergemeinschaft ihre Investitionen auf den Gebieten der Agrarforschung, des technologischen Wandels und des Wassermanagements deutlich erhöhen. Dies vor allem um die Wasserproduktivität und die Kulturpflanzenerträge im Regenfeldbau nachhaltig zu steigern. Ferner wird davon ausgegangen, dass eine zielgerichtete Politik und erhöhte Investitionen in die ländliche Infrastruktur geeignet sind, Landwirten abgelegener Gebiete, den Zugang zu den Märkten zu erleichtern und das Risiko des Regenfeldbaues zu mindern. Zur Stimulierung des sparsamen Umganges mit der Ressource Süßwasser wird es in dem Betrachtungszeitraum (1995 - 2025) zu einem graduellen Anstieg der effektiven Wasserkosten für den Agrarsektor kommen.

Viele Regierungen werden Wasserrechte und Verantwortlichkeiten im Wassermanagement den Wassernutzern übertragen. Sie werden diesen Prozess u.a. begleiten durch Aus- und Weiterbildung der Wassernutzer und durch verschiedene sonstige Unterstützungsmaßnahmen. Als ein Ergebnis dieser Aktivitäten werden die Landwirte ihre eigenen Investitionen in Technologien der Wassereinsparung erhöhen. Die Übernutzung der Grundwasserressourcen wird zu einem Ende kommen, und zwar durch Übertragung von Nutzungsrechten an die Wassernutzer und mit der strengeren und wirkungsvolleren Durchsetzung der relevanten Vorschriften.

Die Nutzung der Wasserressourcen durch Haushalte und Industrie wird gleichfalls eine Erhöhung der Wasserpreise und strengere Vorschriften erfahren. Die Gesellschaft wird die Verbesserung der Umweltqualität in verstärktem Umfang einfordern. Infolge des gesellschaftlichen Druckes wird die Allokation von Süßwasser für Zwecke des Natur- und Umweltschutzes zunehmen und den bestehenden Existenzdruck von den Feuchtbiotopen und relevanten Ökosystemen nehmen.

Bei dem Szenario der nachhaltigen Wassernutzung wird der Wasserverbrauch um 20% niedriger liegen als unter dem Szenario „Business as usual“ . Die Wassernutzung wird eine größere Produktivität aufweisen, besonders in den Entwicklungsländern. Die Wassereinsparungen werden weltweit zu einer Erhöhung der umweltrelevanten Süßwassermengen in der Größenordnung von 1.030 km^3 führen. Die schnellere Steigerung der Erträge im Regenfeldbau wird das langsamere Wachstum der Erntefläche und der Ertäge im Bewässerungslandbau ausgleichen. Im Ergebnis wird die Getreideerzeugung in 2025 insgesamt um 1% über der des Szenarios „Business as usual“ liegen. Die Preise für Produkte der Feldfrüchte werden unter dem Szenario der nachhaltigen Wassernutzung von 1995 bis 2025 langsam fallen. Eine Ausnahme bilden Mais und Sojabohne wegen der zu erwartenden stark ansteigenden Nachfrage nach Futtermitteln.

4 Änderungen in der Wasserpolitik - Konsequenzen

Wissenschaftler des IFPRI sind in Zusammenhang mit ihren Studien zum Einfluss der Allokation der Süßwasserressourcen auf die Nahrungsmittelversorgung auch der Frage nachgegangen, welche Effekte von grundlegenden Änderungen der Wasserpolitik ausgehen (Rosegrant *et al.*, 2002b). Sie haben sich dabei auf drei Gebiete beschränkt und versucht, für folgende Fragen Antworten zu finden: (1) Ist zu erwarten, dass steigende Wasserpreise für die industrielle, kommunale und landwirtschaftliche Nutzung zu größeren Wassereinsparungen führen und die eingesparten Wassermengen für Zwecke des Natur- und Umweltschutzes genutzt werden können? (2) Welche Wirkungen sind auf die Wasserressourcen und Nahrungsmittelerzeugung zu erwarten, wenn es in Regionen, die gegenwärtig eine Übernutzung ihrer Grundwasservorkommen erfahren, eine nachhaltige Wassernutzung erfolgt? (3) Könnte ein schnelleres Wachstum der Getreideerzeugung im Regenfeldbau geringere Investitionen im Bereich der Bewässerung und der Wasserversorgung ausgleichen?

Die Ergebnisse der Untersuchungen des IFPRI zeigen, dass durch Reformen in der Wasserpolitik, dem Wassermanagement und durch gezielte Investitionen die Möglichkeit besteht, die Wassernutzung effizienter und nachhaltiger zu gestalten. Höhere Wasserpreise können demnach zu Wassereinsparungen beitragen und damit die Wasserbereitstellung für Zwecke des Natur- und Umweltschutzes verbessern. Die mit höheren Wasserpreisen verbundenen Effizienzsteigerungen in der Wassernutzung sind als kritisch für die Aufrechterhaltung der Nahrungsmittelerzeugung auf dem Niveau des „Business as usual“ Szenarios anzusehen. Der Erfolg der Wasserpreispolitik hängt von einer zielgerichteten Subvention der armen städtischen Bevölkerung ab und von der Kompensation der durch die Landwirte erzielten Wassereinsparungen, kaum aber von einem exorbitanten Wasserpreisniveau zur Reduzierung des Wasserverbrauchs. Perry (2001) hat sich mit den Möglichkeiten und Grenzen der Erzielung von Effizienzsteigerungen der Wassernutzung in der Bewässerungswirtschaft der Entwicklungsländer mit Hilfe von Wassergebühren befasst. Nach seinen Erkenntnissen steht der finanzielle, technische, gesetzliche und administrative Aufwand meist in keinem Verhältnis zu dem zu erwartenden Nutzen. Dies vor allem, wenn man eine volumenbezogene Wassergebührenerhebung anstrebt.

Die Einstellung bzw. die Durchsetzung des Verbots einer nicht nachhaltigen Grundwassernutzung würde zu einer Minderung der Getreideerzeugung führen. Dies vor allem in Gebieten, die schon heute eine deutliche Übernutzung aufweisen, wie z.B. China und Indien. Daraus würde resultieren, dass die Länder der Dritten Welt insgesamt ihre Netto-Getreideimporte erhöhen und die entwickelten Länder ihre Exporte steigern müssten. Diese Veränderungen können durchaus als sinnvoll hinsichtlich des Wiederherstellens nachhaltiger Grundwasservorräte angesehen werden. Sie müssen allerdings kombiniert werden mit politischen Maßnahmen zur Steigerung der Effizienz der Wassernutzung. Zusätzlich ist die Hinwirkung auf eine Diversifizierung des Anbaues in der Bewässerungslandwirtschaft mit dem Ziel erforderlich, den Getreideanbau zu ersetzen durch Kulturen, die einen höheren Geldertrag pro eingesetzter Wassermenge ermöglichen. Zusätzlich ist die Schaffung von Einkommensmöglichkeiten außerhalb des Agrarsektors in den ländlichen Gebieten erforderlich, die durch eine Übernutzung der Grundwasserressourcen gekennzeichnet sind.

Wenn eine Reduzierung der Investitionen in den Bereichen Bewässerung und Wasserbereitstellung vorgenommen und dies kombiniert würde mit einer Steigerung der Erträge und einer Ausdehnung der Erntefläche im Regenfeldbau, dann würde es, nach Erkenntnissen der IFPRI/IWMI Studie, zu einer Verringerung des Wasserverbrauchs der Bewässerungslandwirtschaft in der Größenordnung von 16% kommen. Die Landwirte würden im Bewässerungslandbau 153 Mio. Tonnen weniger Getreide erzeugen, als dies unter dem Szenario „Business as usual“ der Fall wäre. Aber die Landwirte, die Regenfeldbau betreiben, würden im Gegenzug unter diesem Szenario 187 Mio. Tonnen Getreide mehr produzieren. Dabei ist allerdings nicht berücksichtigt, dass die Erzeugung im Regenfeldbau aufgrund der Unsicherheit der Niederschläge deutlich unsicherer ist als im Bewässerungslandbau.

Wenn die Landwirtschaft im Gegenzug zu den verminderten Investitionen in den Bereichen Bewässerung und Wasserbereitstellung im Regenfeldbau lediglich vermehrt und intensiver Wasserkonzentrationsanbau, konservierende Bodenbearbeitung und Präzisionsanbau betreiben würde, könnte sie unter einem solchen Szenario die Erzeugung deutlich steigern. Aber sie könnte damit nicht die durch den Rückgang der Bewässerung bedingten Ausfälle ausgleichen. Vor allem die Entwicklungsländer würden durch eine solche Entwicklung hart getroffen. Sie müssen ihre Getreideimporte um 16 Mio. Tonnen erhöhen. Angemessene Investitionen und Reformen auf der Politikebene, einschließlich pflanzenzüchterischer Maßnahmen für die Standorte des Regenfeldbaues sind erforderlich, um den Beitrag des Regenfeldbaues zu erhöhen und abzusichern.

Unzweifelhaft bestehen Möglichkeiten, das Ertragspotential des Regenfeldbaues besser zu nutzen. Ob allerdings so große Produktionssteigerungen zu erzielen sind, dass es dadurch zu einer Entlastung des Bewässerungslandbaues und der Süßwasserressourcen kommt, erscheint fraglich. Der Regenfeldbau ist den letzten Jahrzehnten zunehmend in Gebiete vorgedrungen, die aufgrund der Ungunst der natürlichen Standortverhältnisse auf Dauer als nicht ackerfähig, als Grenzstandorte, anzusehen sind. Im Zuge der wirtschaftlichen Entwicklung ist nach den Erfahrungen in den entwickelten Ländern davon auszugehen, dass sich der Ackerbau von den Grenzstandorten wieder zurückzieht. Dies

vor allem, weil hier auf Dauer keine Einkommen zu erwirtschaften sind, die den steigenden Einkommenserwartungen der Landwirte entsprechen (WOLFF *et al.*, 1995).

5 Schlussfolgerungen

Die Studie des IFPRI und IWMI, deren Ergebnis u.a. die oben kurz skizzierten Szenarien sind, macht deutlich, dass es großer Anstrengungen bedarf, um zu einer nachhaltigen Süßwassernutzung zu gelangen. Sie zeigt auch, dass es unverantwortlich wäre nicht zu handeln, die Dinge einfach laufen zu lassen. Ein solches Nichthandeln würde unweigerlich in eine Wasserkrise, in eine Katastrophe führen.

Zur Abwendung einer solchen Katastrophe ist ein holistisches, nachhaltiges Wassermanagement bzw. eine nachhaltige Wasserwirtschaft erforderlich, d.h. die integrierte Bewirtschaftung aller künstlichen und natürlichen Wasserkreisläufe. Dabei sind drei wesentliche Zielsetzungen zu beachten:

- Wasser als Lebensraum bzw. als zentrales Element von Lebensräumen langfristig schützen,
- Wasser in seinen verschiedenen Facetten als Ressource für die jetzige wie für folgende Generationen sichern,
- Wege zu einer dauerhaft naturverträglichen, wirtschaftlich effizienten und sozial gerechten Entwicklung finden.

Die Lösungen, die zum Ziel führen, dürfen die nachhaltige Entwicklung anderer Umweltsektoren nicht beeinträchtigen (ATV-DVWK, 2001).

Die Entwicklung und Umsetzung eines nachhaltigen Wassermanagements, von der Haushaltsebene bis hin zur Wassereinzugsgebietsebene, erweist sich in der Praxis oft als außerordentlich schwierig. Es bedarf hier eines entsprechenden Bewusstseins der Wassernutzer, der Bereitschaft der vertrauensvollen Zusammenarbeit aller Beteiligten, der Unterstützung der politisch Verantwortlichen, einer angemessenen Investitionsbereitschaft und der Schaffung von Rahmenbedingungen, die einem nachhaltigen Wassermanagement förderlich sind.

Die schwächsten Glieder bei der Allokation oder Reallokation der Süßwasserressourcen stellen ohne Zweifel die armen Bevölkerungskreise der Entwicklungsländer und die natürlichen Ökosysteme (Feuchtbiotope etc.) dar. Während die Ökosysteme über eine wachsende Lobby verfügen, sind die Armen weitgehend sich selbst überlassen. Sie sind weder bei der häuslichen Wasserver- und -entsorgung, noch bei der Bewässerung in der Lage, ihre Interessen angemessen zu vertreten und die notwendigen Mittel aufzubringen, um eine effizientere Nutzung der Süßwasserressourcen nachhaltig zu bewerkstelligen. Hier kann kaum auf Unterstützungsmaßnahmen, d.h. Subventionen verzichtet werden. Subventionen allerdings sind einem nachhaltigen Wassermanagement nicht unbedingt förderlich.

Die in der IFPRI/IWMI Studie getroffenen Annahmen können nicht in allen Fällen als gesichert angesehen werden. Sie bedürfen zumindest der Überprüfung durch entsprechende Feldstudien. Hier ist die Wissenschaft gefragt. Der Feststellung, dass dem sich

abzeichnenden oder bereits bestehenden Wassermangel am wirkungsvollsten durch eine effizientere Wassernutzung zu begegnen ist, kann ohne Einschränkung zugestimmt werden. Allerdings ist die Effizienzsteigerung oft nur mit einem erheblichen Aufwand zu erreichen, einem Aufwand, der nur zu oft jenseits der wirtschaftlichen und/oder betriebstechnischen Möglichkeiten liegt. Als Möglichkeiten einer effizienteren Wassernutzung in der Bewässerungswirtschaft wird z.B. die Umstellung auf Tropfbewässerung, Einführung einer bedarfsorientierten Bewässerungssteuerung etc. angesehen. Vergessen wird dabei, dass die Anwendung der Tropfbewässerung zahlreichen Restriktionen unterliegt und nur unter bestimmten Voraussetzungen wirkungsvoll eingesetzt werden kann (Wolff, 1987). Die Anwendung einer bedarfsorientierten Bewässerungssteuerung setzt ein Unterstützungssystem (Bewässerungsberatung), eine freizügige, zeitlich und mengenmäßig nicht zu eng begrenzte Wasserbereitstellung sowie ein schlagkräftiges Bewässerungssystem voraus. Hinzu kommt, dass die Effizienzsteigerung nicht in erster Linie eine technische Frage ist. Sie wird vor allem durch die sozioökonomischen Bedingungen bestimmt, unter denen der einzelne Landwirt wirtschaftet.

Die internationale Gemeinschaft hat sich in den letzten Jahrzehnten verstärkt dem Wasserproblem angenommen. Das Wasserproblem war Gegenstand einer Vielzahl internationaler Konferenzen und verschiedener Initiativen. Schon die UN Water Conference in Mar del Plata, Argentinien im März 1977 und in jüngerer Zeit die International Conference on Water and Environment 1992 in Dublin, Irland sowie die International Conference on Freshwater 2001 in Bonn, Deutschland haben einen zwingenden Handlungsbedarf auf dem Gebiet des Wassermanagements und der Wasserpolitik deutlich gemacht. Es gelang zwar, durch diese Konferenzen und verschiedene sonstige Aktivitäten das Wasserproblem der Öffentlichkeit bewusst zu machen. Auch wurden durchaus Fortschritte in Teilbereichen des Managements der Wasserressourcen erzielt. Ein wirklicher Durchbruch zu aktivem, sektorübergreifendem Handeln blieb jedoch weitgehend aus. Hier will die UNO mit dem Internationalen Jahr des Süßwassers 2003 ansetzen. Sie will damit der nachhaltigen Nutzung und dem Schutz der Süßwasserressourcen zum Durchbruch verhelfen. Um jedoch weltweit zu einer nachhaltigen Nutzung und zu einem integrierten Management der Süßwasserressourcen zu gelangen, sind noch beachtliche Anstrengungen seitens der Politik, der Wissenschaft, der Administration und der wasserwirtschaftlichen Praxis sowie der Wassernutzer erforderlich.

6 Zusammenfassung

Die Vollversammlung der Vereinten Nationen hat das Jahr 2003 zum „Internationalen Jahr des Süßwassers“ erklärt und die UNESCO mit der Federführung beauftragt. Aus Anlass dieses Ereignisses wird in der vorliegenden Arbeit die konkurrierende Nachfrage nach Süßwasser kurz skizziert. Dabei wird deutlich, dass die Süßwasserressourcen sich weltweit in einer argen Bedrängnis befinden und dass es eines sektorübergreifenden Handelns bedarf um eine drohende Wasserkrise abzuwenden.

Anhand der Ergebnisse einer Studie des International Food Policy Research Institute (IFPRI) und des International Water Management Institute (IWMI) werden drei Alternativen der künftigen Süßwassernutzung beschrieben. Dabei wird deutlich, dass

die Lösung der Probleme nur in einem nachhaltigen, integrierten Wassermanagement bzw. einer nachhaltigen Wasserwirtschaft liegen kann. Um dies zu erreichen bedarf es großer Anstrengen der an der Bewirtschaftung aller künstlichen und natürlichen Wasserkreisläufe Beteiligten, einschließlich der Wassernutzer. Dies nicht nur um die Nachhaltigkeit der Süßwasserressourcen bzw. deren Nutzung zu gewährleisten sondern auch um die Ernährung der wachsenden Weltbevölkerung sicherzustellen.

Literatur

ATV-DVWK; *Nachhaltige Wasserwirtschaft. Teil 1: Abwasser*; ATV-DWK-Informationen; ATV-DVWK Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V., Hennef; 2001.

Deutsche UNESCO-Kommission; 2003 - Internationales Jahr des Süßwassers; UNESCO heute online. Online-Magazin der Deutschen UNESCO-Kommission, Ausgabe 12; 2002.

Perry, C.; Charging for Irrigation Water: The Issues and Options, with a Case Study from Iran; International Water Management Institute (IWMI), Research Paper No. 52; Colombo/Sri Lanka; 2001.

Rijsberman, F.; Water for Food and Environment: The Need for Dialogue; *Entwicklung+ländlicher Raum*; 5:8 – 11; 2001.

Rosegrant, M., Ximing, C. and Cline, S.; Global Water Outlook to 2025: Averting an Impending Crisis; Food Policy Report. International Food Policy Research Institute (IFPRI), Washington, D.C. und International Water Management Institute (IWMI), Colombo/Sri Lanka; 2002a.

Rosegrant, M., Ximing, C. and Cline, S.; World Water and Food to 2025: Dealing with Scarcity; International Food Policy Research Institute (IFPRI), Washington, D.C.; 2002b.

UNESCO; International Year of Freshwater 2003: Facts and Figures: Water Use; http://www.wateryear2003.org; 2002.

Wolff, P.; Tropfbewässerung - Erfahrungen und Möglichkeiten; *Der Tropenlandwirt*; 88:53 – 65; 1987.

Wolff, P.; Die Wasserwirtschaft in der Dritten Welt im Wandel; *Journal of Agriculture in the Tropics and Subtropics Vol. 103, ehem. Der Tropenlandwirt*; 103(1):1–16; 2002.

Wolff, P., Glauner, H. and Hübener, R.; Pro und Contra: Haben die marginalen Agrarwirtschaftsräume der Entwicklungsländer eine Zukunft?; *Der Tropenlandwirt*; 96(1):3 –13; 1995.

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Land-Use Changes in the Upper Lam Phra Phloeng Watershed, Northeastern Thailand: Characteristics and Driving Forces

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Abstract

For a typical smallholder agricultural area in northeast Thailand, this paper describes the land-use changes, their main driving forces and their consequences over the last forty years - from the conversion of the original forest to the present agricultural land use.

The area has a relatively short agricultural history. From the 1960s onward, people started to settle in the area and began to clear-cut the forest to grow subsistence crops, such as upland rice and castor beans. After a relatively short period dominated by subsistence crops, the land use rapidly developed into maize-based cash-crop systems. Maize is still the main crop. Since the beginning of agriculture in the area, the farmers practiced continuous cropping. Shifting cultivation was never practiced. Initially, the soil was not tilled, and dibbling of seeds was exclusively practiced. All soil and crop husbandry practices were carried out manually. Due to the influx of more people, the agricultural land area expanded rapidly. Most of the land remains government property. Only recently, limited land-use rights for the farmers are being issued. With the change of the land-use systems over time, i.e., from upland rice to maize, and from subsistence to more market-oriented farming, the agronomic practices also changed adapting to the requirements of the new crops. The application of inorganic fertilizers, herbicides and pesticides became standard practice. The use of these inputs led to a significant increase in land productivity. However, most farmers do not have sufficient capital to purchase all required inputs fore cultivation and they largely depend on private money lenders and middlemen for input supply at extremely high interest rates.

There is a general perception amongst farmers of a considerable soil-fertility decline and that more and more fertilizer needs to be applied to maintain the current yield levels. To realize more sustainable agriculture, land-use technologies need to be adopted at the farm level that increase the efficiency of nutrient and organic matter cycling and reduce soil-degradation risks. Simultaneously, an enabling environment needs to be developed based on appropriate extension services and adequate credit facilities for the farmers.

Keywords: cropping systems, forest clearing, land productivity, land-use change, Thailand

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1 Introduction

The conversion of land from natural vegetation -forest in many cases- to agricultural land uses is often perceived as environmentally degrading, especially in terms of rapidly declining soil quality. Claims are being made that intensively used agricultural areas cannot buffer the adverse effects of agriculture on the environment (Islam and Weil, 2000). However, the need to secure and increase land productivity in order to survive is crucial for many people in rural areas, especially in the developing world, who therefore need to expand -and subsequently develop- agricultural areas in order to secure their livelihood (Brookfield, 2001). Pressure on the land inevitably leads to changes in land use, basically triggered by the need to achieve higher agricultural production (Nielsen and Zoebisch, 2001; Zoebisch and De Pauw, 2002). Land-use changes are typically characterized in terms of changes of crops, land-husbandry practices and inputs used, such as capital, labour, fertilizers and pesticides. (Pulleman *et al.*, 2000).

This paper addresses the issues of land-use changes in three typical villages in the rainfed farming areas of northeast Thailand. It aims to provide an overview of the land-use changes in the area in the context of the conditions, the driving forces and the consequences on the management of the land.

It has commonly been observed that clearing and cultivation of forestland leads to a deterioration of the physical, chemical and biological properties of soils and that reforestation measures gradually restore soil quality (Islam and Weil, 2000)(Islam and Weil, 2000). However, with appropriate land-use technologies that are suited to the location-specific needs of an area, even under continued permanent agricultural land use, soil quality can be maintained and improved (Kotto-Same *et al.*, 1997). In northeastern Thailand for instance, the intercropping of maize with legumes, such as spineless mimosa (*Mimosa invisa*) or pigeon pea (*Cajanus cajan*) resulted in higher grain yields than the conventional continuous monocropping of maize and led to a better protection of the soil against erosion and an overall improvement of the soil quality (Suwanarit *et al.*, 1999). Similar positive effects on soil quality have been found with sequential cropping systems, contour tillage, and contour-strip and hedgerow cultivation methods (Poudel *et al.*, 2000; Thapa *et al.*, 2001).

With increasing pressure on the land, changes in land use that lead to higher land productivity appear to be unavoidable. The rainfed farming areas of northeastern Thailand are typical examples of rapid land-use changes prompted by the rapid increases in productivity needs and expectations of the land users. In order to identify land-use technologies that match productivity expectations with environmental concerns and secure the maintenance of soil quality, it is important to understand the conditions and driving forces that lead to changes in land use.

2 Methodology

2.1 Study area

This paper is based on a case study carried out in three typical villages in the rainfed farming areas of northeast Thailand. The villages (*Ban Pong Chanuan, Ban Takien*

Ngam, and *Ban Thep Nimitr*) are located in the western upper reaches of the *Lam Phra Phloeng* watershed, Nakhon Ratchasima Province, bordering the *Khao Yai National Park*. The area is characterized by a generally hilly topography, with undulating slopes and few flat areas. Elevations range from 200 m.a.s.l. in the northeastern parts to about 1,150 m.a.s.l. in the southwestern parts of the watershed. The climate is influenced by both the northeast and southwest monsoons, leading to a bimodal rainfall pattern with an average annual rainfall of around 1,000 mm. The northeast-monsoon rains occur from November to February, and the southwest-monsoon rains from May to September. The mean monthly maximum temperature ranges between 37° C (April) and 27° C (December), and the mean monthly minimum temperature ranges between 24° C (June) and 14° C (December). The soils in the area are dominantly Ultisols (*Korat* Series) with low inherent fertility (LDD, 2002). Soil textures vary from loamy to clayey sands. Originally, the area was under evergreen forest, which, these days, can only be found in the adjacent *Khao Yai National Park*.

The administrative territory of the three villages has about 48 % agricultural land and 52% forest (incl. dry evergreen forest, secondary natural re-growth, and reforested areas). All of this forest belongs to the national park and cannot be used for farming. Of the agricultural area, 72% are cultivated for field crops and about 18% is covered by orchards. Irrigated vegetables and marigold flowers are important crops, but their areas are small, mainly because of limited irrigation-water availability. Maize is the dominant crop, but significant areas are also planted to mungbean. The main fruit grown is mango, but there are also plantations of custard apple, tamarind, papaya, and jackfruit. The main vegetables grown are eggplant, yellow chili, Chinese kale, and cabbage. The average farm size in the three villages studied is 8.2 ha, ranging from 0.8 ha to 32 ha, with only a few farms with more than 15 ha.

In the lower reaches of the watershed, agriculture has been practiced for a long time and the forests have completely disappeared. The upper reaches of the watershed still have some forest cover, especially in the areas bordering the national park. Since 1980, in this part, considerable areas used for agriculture have been declared 'protected buffer zone' for the national park (i.e., watershed protection areas). Most of this buffer zone has been left for natural forest re-growth, but some areas have been re-afforested recently.

2.2 Data collection

The study is based on individual and group discussions with farmers. For general information on farming systems and practices structured questionnaires were used. The interviews on the land-use changes were of the discussion-type and open-ended. Because of the special interest in the land-use history, only the older farmers, who have witnessed and took part in the initial forest clearing and cultivation of the area -and who have observed the land-use changes since then- have been included in the study. Thirty-eight individual interviews were conducted. During each interview a visit was made to the farmer's fields. In each village, two group discussions were organized with 5 - 6 participants. During the group discussions, typical different land-use successions that took place in the villages were identified and described.

3 From Forest to Cropland: Land-Use Dynamics

The settlement and land-use histories of the three neighboring villages studied are typical for the recent agricultural settlements in the former forested areas of northeastern Thailand. Although the villages followed different pathways there were common general trends of land clearing and land use in the area that led to the current maize-dominated cropping pattern.

Driven first by the subsistence needs of relatively small numbers of settlers, the increased influx of more people and the need to grow cash crops to satisfy cash-income requirements accelerated the forest clearing. After only about three decades the forest cover in the area had disappeared almost completely to make room for agriculture. The villages are located in the buffer zone of the national park and the present forest cover has largely been preserved and re-established due to the land-use restrictions within and in the vicinity of the national park.

Since the 1960s, the land-use in the area has changed remarkably. Initially, the area was dense natural forest. Due to the increasing population, more land was needed to grow crops. From 1960 to 1970, small groups of people settled in the area. They clear-cut patches of forest to cultivate upland rice, cotton, peas, beans, and vegetables for home consumption. The development of agriculture in the area was very slow at that time. Communication and transportation were difficult because there were no roads in the area. In 1960, the boundaries between the *Khao Yai National Park* and the villages were officially established. The Forest Industries Organization (FIO) had forest concessions and the farmers used to fell big timber trees for the FIO. This way, the forest gradually deteriorated. To exploit the timber, a simple road network was developed. The road network also enabled the people to reach the neighboring villages and the district town more easily. This opened market opportunities and encouraged the farmers to produce crops for sale on the cleared land and enabled them to buy other products. Because growing upland rice -used for home consumption- was labor demanding and it could easily be bought at the market it was increasingly being replaced with maize, which could be sold to feed mills, and oil-extraction and starch factories. This was a growing market.

Shifting cultivation was never practiced in the area. After forest clearing, most of the land was directly used for continuous cropping of maize (2 crops per year). This practice continued for about 30 years without regular fallowing. A number of farmers then began to plant mungbean after each maize harvest replacing the second crop of maize within the same year. However, most farmers still continue to plant two crops of maize within a year.

Around 1970, most of the forest had disappeared and maize had become the overwhelmingly dominant crop in the area. The livelihood of the farmers depended almost exclusively on maize. Cotton growing that had also been taken on in the area was stopped due to increasing pest problems, further increasing the area under maize. Around 1971, due to attractive producer prices for mangoes, a considerable number of farmers started to grow mangoes which used to be intercropped with maize for the first three years

after the establishment of the plantations. But already twenty years later, i.e., around 1990, the productivity of the fruit trees had declined considerably. For several years, the trees did not bear any fruits. This was because most of the farmers did not have the skills and experience for adequate tree management, and they did not have the equipment to apply pesticides to the trees. There was no extension service which could provide advice. Therefore many farmers uprooted their mango trees and changed again to growing maize, to vegetables, or both. Thus, the dependency on maize was again increasing. Generally, the farmers now realize that they have to apply more inputs these days to maintain the yields at current levels.

The land the farmers had cleared from the forest remained government property. Some farmers received rights of use for agriculture that could be handed over to their children, but the land could not be sold. However, without full land ownership, the farmers could not get loans from the agricultural or cooperative banks. Small farmers still face significant difficulty to obtain the required investment capital to buy the needed inputs (e.g., machinery hire, seeds, fertilizers, pesticides) for their crops. Most farmers have to borrow money from private sources, especially from the middlemen. The interest rate is around 5 percent per month (i.e., 60% per year). Hence, many farmers depend totally on the middlemen to grow their crops. Because of the high input costs and high interest rates, the farmers cannot build up sufficient savings after harvest to finance the following cropping season, and they feel that they do not have any alternatives to this situation.

4 Land-Use Successions: Driving Forces of Land-Use Change

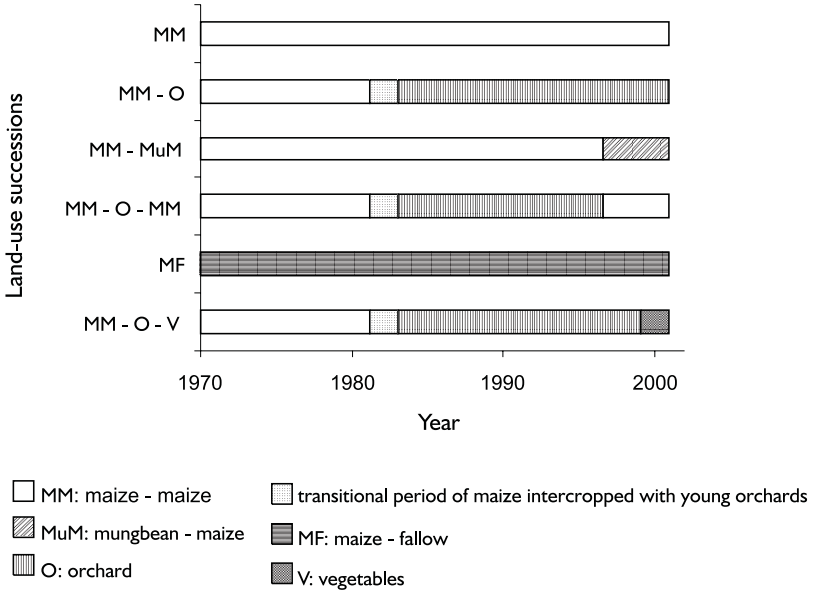
Six typical land-use successions have been identified in the area (Figure 1). All of these successions indicate the clear orientation of the farmers towards cash crops. Maize remains the dominant crop, as maize-maize (i.e., two maize crops per year), maize-mungbean, and maize-fallow rotation. Orchards are increasingly phased out, due to a declining productivity of the trees.

The reasons and driving forces behind the changes in land-use and management are basically based on changing market opportunities and declining productivity (i.e., yields) of crops. Specifically, the driving forces that triggered the change from one crop to another can be characterized as follows:

Forest $\longrightarrow$ upland rice, cotton, beans, and vegetables
Landless people from other rural areas started to settle in the forest along the streams. Because their livelihood was based on subsistence there was a need for agricultural land. There were no alternative income-generation opportunities. After they clear-cut patches of forest they immediately practiced continuous cultivation which they had already been practiced in their places of origin. They never practiced shifting cultivation typical for indigenous forest dwellers. The first main crops grown were upland rice and vegetables.

Upland rice $\longrightarrow$ maize-maize (2 crops per year) rotation
After road construction, farmers could easily access the cash-crop market. Rice -the main staple food- was available on the market at relatively low cost, and because of the

Figure 1: Typical land-use successions in the study area after forest clearing.



high time and labor requirement its cultivation was given up. Maize for the market was planted instead because of its attractive producer prices. Moreover, upland rice could only be grown once a year and the land lay fallow until the next main growing season. With maize, two crops per year were possible, increasing cash-earning opportunities.

Maize-maize $\longrightarrow$ maize-fallow (1 crop per year) rotation
Some of the larger farmers wanted to avoid the risk of drought stress frequently causing failure of the second maize crop due to erratic rainfall and leading to a loss of inputs (e.g., time, labor, fertilizer). Therefore only one crop of maize per year (August- December/January) was planted, followed by a short fallow period until the next year's growing season.

Maize-maize (2 crops per year) rotation $\longrightarrow$ orchard
Because of attractive prices for mangoes in the early 1970s and a perceived low labor demand, mango-tree plantations were established. Local and regional market opportunities were good. Orchards are still being established, but mainly of custard apples. In the first 3 years after establishment, i.e., before fruit bearing, the plantations can be intercropped with maize. This provides some cash income for the farmer from the plot.

Orchard $\longrightarrow$ maize-maize (2 crops per year) rotation
Since many farmers converted part of their maize growing areas to mango orchards the prices of the fruits decreased. Some farmers did not have adequate sprayers to apply pesticides to the trees, and the hire of the additionally required labor to maintain the orchards was very costly. In 15 to 20 years old trees, the quality of the fruit also

deteriorated (especially the size of the fruits) and the overall tree productivity declined. There were some years without any fruit on some trees. Therefore, many farmers uprooted their orchards and began to grow maize again. The uprooted trees were made into charcoal for home consumption.

Maize-maize (2 crops per year) $\longrightarrow$ mungbean-maize rotation
To reduce the risk of drought damage during the flowering stage (September, October), mungbean was promoted by the agricultural extension service as a replacement for the second maize crop in the year. Some farmers changed their maize-maize system to mungbean-maize rotation. Mungbean as a short-life-cycle legume crop fits well into the annual rainfall pattern, and it can reduce the risk of drought damage that exists with the second maize crop.

Orchard $\longrightarrow$ vegetables
Where irrigation water is available, some farmers changed to horticultural cash crops, such as vegetables (chili, aubergine, mustard, cabbage, Chinese cabbage, kale, etc). Vegetables have good local and regional market opportunities and can earn fast cash income.

5 Changes in Land-Use Technologies

The land and crop-husbandry practices have changed along with the changes in crops and the general availability of inputs and the need for their application, especially fertilizers and pesticides. An overview of the changes in crop and land-husbandry practices by the farmers in continuous maize-maize, maize-orchard, and continuous maize to mungbean-maize land-use successions are given in Tables 1, 2, and 3, respectively. The tables show a general trend to increased use of external inputs and mechanization.

The main observed changes in land-use technologies in the area can be characterized as follows:

Land preparation
Since around 1980, because of the need to cultivate larger areas to secure the increasing requirements for higher farm returns, the farmers have changed from hand hoeing and animal powered tillage to tractor drawn land-preparation. This led to more intensive soil mixing and deeper tillage. Also, due to the nature and capacity of large machinery, the direction of tillage is often across the contour, thus encouraging soil erosion. The equipment is almost exclusively hired from contractors because the farmers cannot afford to purchase and maintain expensive machinery.

Crop varieties
Almost all farmers have abandoned the local varieties and are using hybrids that were introduced by the agricultural extension service and the seed companies through the middlemen who provide the inputs to the farmers. The main reason for the adoption of hybrid varieties was the higher yields. But these varieties also require high fertilizer input. Several different hybrid varieties are available and the farmers usually use the varieties provided by the middlemen.

Table 1: Overview of the changes in land and crop-husbandry practices: continuous maize - maize land-use succession (2 crops per year)

Activity	**Period**			
	1961-1970	1971-1980	1981-1990	1991-2001
Variety selection	- Local (Kaen Daeng)	- Local Kaen Daeng)	- Local - Suwan (started around 1986)	- Suwan*(about 1986-1993) - 888 (about 1994-1995) - Pioneer (1996-1997) - Cargil** (After 1997)
Land preparation				
- Ploughing	- Manual	- Tractor	- Tractor	- Tractor
- Ridging	- Manual	- Cattle/Buffalo	- Tractor	- Tractor
- Seeding	- Manual	- Manual	- Tractor	- Tractor
Planting method	Dibbling	Broadcasting	Sowing machine	Sowing machine
Weed control	- Hand weeding	- Hand weeding - Buffalo ploughing between rows	- Hand weeding - Buffalo ploughing between rows	- Introducing herbicides Grammoxone (2.5-3 l ha^{-1}) Atrazine (3-3.5 l ha^{-1}) About 25 d.a.p. ***
Fertilizer application	- No fertilizer used	- No fertilizer used	- No fertilizer with local variety	
First application Amount (kg ha^{-1}) Type			- With land preparation - 60 to 70 kg ha^{-1} - 16-20-0 or 20-20-0 or 15-15-15	- With land preparation - 135 to 140 kg ha^{-1} - 16-20-0 or 20-20-0 or 15-15-15
Second application Amount (kg ha^{-1}) Type (and or not)			- 45 d.a.p*** - 70 to 80 kg ha^{-1} - 16-20-0 or 20-20-0 or 15-15-15	- 45 d.a.p*** - 155 to 160 kg ha^{-1} - 16-20-0 or 20-20-0 or 15-15-15
Second application Amount (kg ha^{-1}) Type			- 45 d.a.p*** - 80 to 90 kg ha^{-1} - Urea	- 45 d.a.p*** - 180 to 185 kg ha^{-1} - Urea
Harvesting	- Picking cobs by hand	- Picking cobs by hand	- Picking cobs by hand	- Picking cobs by hand
Threshing	- Manual	- Manual	- By middlemen or cooperative	- By middlemen or local cooperative
Residue and fallow management	- Residue burned after harvest; land left bare for about 2 months until next crop	- Residue burned after harvest; land left bare for about 2 months until next crop	- Residue burned after harvest; land left bare for about 2 months until next crop	- Residue bent down and left in the field until the next land preparation (practice started 1997)

Notes: * Suwan series (1 or 2 or 3 or 5) ** Cargil varieties (919 or 929 or 939 or 949 or 979 or 717 or 747)

*** dap = days after planting

Table 2: Overview of the changes in land and crop husbandry practices: Maize to orchard land-use succession

Particular	1961-1970	1971-1980	1981-1990	1991-2001
Land preparation				
- Ploughing	- Manual	- Tractor	- Orchard	- Orchard plantation
- Rowing	- Manual	- Cattle/Buffalo	plantation (fruit	
- Seeding	- Manual	- Manual	trees)	
Variety selection				
- Local (Kaen Daeng)	- Local	- Local	- Local	- Orchard; Local and
- Suwan	- Local	- Local	- Suwan	improved**
	- Local	- Local	- Orchard;Local*	
Planting method	- Dibbling	- Dibbling - Broadcast, some who have cattle or buffalo	- Sowing machine - Spacing (Inter-crop planted maize with orchard)	- After 4-5 years intercropping, stopped maize planting in the orchard. Grafting with improved variety during rainy season when the trees are 8-9 years old.
Weeding	- Hand weeding	- Hand weeding or buffalo ploughing	- Hand weeding or buffalo ploughing	- Hand weeding or buffalo ploughing - Cutting grass by knife (2 times per year) or ploughing with small tractor between rows of trees
Fertilizer application	- No fertilizer used	- No fertilizer used	- No fertilizer used	- Started to apply about 5 years ago
- Time				- After pruning
- Amount				- 0.5 to 1 kg per tree
- Type				- 16-20-0 or 15-15-15
- Method				- Basal placement
Pruning				- 1 time per year after harvest - Some farmers: 1 time every 2-4 years - Some farmers: never prune
Harvesting	- Manual (maize)	- Manual (maize)	- Manual (orchard)	- Manual (orchard)
- Yields		- Local: (3500 - 3600 kg ha^{-1} - Suwan: 4300 - 4400 kg ha^{-1}	- 60 kg per tree	- 60 kg per tree reduced to → 0-20 kg per tree
- Fruits (buying)			- By middlemen	- By middlemen
Residue management	- Burned after harvest	- Burned after harvest	- Piling of the pruned branches at the base of the trees	- Piling of the pruned branches at the base of the trees and - Some make charcoal by clear-cut of mango trees for home consumption
Land management	- About 2 months bare land between successive crops	- About 2 months bare land between successive crops	- About 2 months bare land between successive crops	- Cattle grazing in the orchard field; some leave as it is, and some clear-cut (18-20 yrs old fruit trees) and change to maize and/ or vegetable cultivation

Notes: *Kaew ** Nam dok mai, Fa lan, Keuw Sawey, Thong dam, Oak rong, Nong saeng, Pim sean

Table 3: Overview of the changes in land and crop husbandry practices: Maize - maize to mungbean - maize rotation land-use succession

Particular	1961-1970	1971-1980	1981-1990	1991-2001
Land preparation				
- Ploughing - Ridging - Seeding	- Manual - Manual - Manual	- Tractor - Cattle/Buffalo - Manual	- Tractor - Tractor - Tractor	- Tractor - Tractor - Tractor
Variety selection	(maize) - Local (Kaen Daeng)	(maize)	(maize) - Local - Suwan (started about 1986)	(maize, mungbean) - Suwan - 888 - Pioneer - Cargil - local variety for mungbean
Planting method	- Dibbling	- Dibbling or broadcast	- Sowing machine	- Sowing machine
Herbicide application - Time - Amount (kg/ha) and type	- Hand weeding	- Hand weeding or buffalo ploughing	- Hand weeding or buffalo ploughing	- Start to use - 25 d.a.p. - 2.5 to 3 l/ha, Gramoxone - 3 to 3.5 l/ha, Atrazine
Fertilizer application (for maize) - Time (first) - Amount (kg/ha) - Type - Time (second) - Amount (kg/ha) - Type (and /or/not) - Time (second) - Amount (kg/ha) - Type	- No fertilizer used	- No fertilizer used	- Not used for maize, local variety	- With land preparation - 60 to 70 increased to 135-140 - 16-20-0 or 20-20-0 or 15-15-15 - 45 d.a.p. - 70 to 80 increased to 155-160 - 16-20-0 or 20-20-0 or 15-15-15 - 45 d.a.p. - 80 to 90 increased to 180-185 - urea
(for mungbean) - Time - Amount (kg/ha) - Type - Hormone				- With land preparation - 89 - 16-20-0 or 15-15-15 (only new farmers use) - Gibberellin + mixed nutrients (1l/ha); spray 45 d.a.p (almost all farmers use)
Yields (kg ha^{-1})	- Local: 3500-3600	- Local: 3500-3600	- Suwan: 4300-4400 - 888: 4400-4500 - Cargil: 5100-5200	- mungbean: 600-650
Residue management	- Burned after harvest	- Burned after harvest	Burned after harvest	Bent down and leave in the field until next land preparation
Fallow period	2 months bare land	2 months bare land	2 months bare land	2 months fallow after mungbean & 2 months fallow after maize

Use of fertilizers
Fertilizers have only been used widely for the past 5 years, and only for the hybrid varieties. While all farmers use fertilizers for maize, only a few apply fertilizer to mungbean. The rates of application have doubled since fertilizer was first used, from around 210 kg ha^{-1} five years or longer ago to about 470 kg ha^{-1} at present.

Use of herbicides and pesticides
When crop cultivation began in the area, farmers practiced hand-weeding, using bush knives to cut the weeds (i.e., mainly grasses). With the introduction of draught animals (i.e., buffaloes) ploughs were used to control the weeds. With increasing agricultural mechanization, weed and pest control with herbicides and pesticides has eventually replaced mechanical weed control.

Pruning of fruit trees
Many farmers do not prune their trees regularly. However, they do apply some fertilizer. Around 1985, the fruit yields of mango trees were about 60 kg per tree and year. Current yields have dropped to about 20 kg per tree and year. Some of the 18-20 year old trees have stopped producing fruit. This has been the reason for increased uprooting of the trees.

Harvesting and threshing
Initially, both harvesting and threshing were done manually. Cob harvesting is still done exclusively by hand, but since about 1990, threshing is only done by machinery at the agricultural cooperative.

6 Technology-Development Needs and Options

The changes in land use also brought along changes in crop and land husbandry practices. More intensive cultivation of larger areas led to a higher degree in mechanization, especially soil tillage. Expectations for higher crop productivity led to the introduction of hybrid maize varieties together with chemical fertilizers and pesticides. This again increased the level of inputs needed to produce a crop. Thus investment costs increased beyond the capacity of most farmers and there was a need for credit.

The farmers have no control over the sale of their maize crop, because they are bound to deliver their harvest to the creditors to pay back their loans 'in kind'. This creates a permanent dependency on the money lenders and the farmers effectively become contract workers for the creditors, with no or very little profit and virtually no room for long-term investment into the development of their farms. The farmers are aware that, in the long term, the fertility of their soils will decrease because of a lack of soil-fertility maintenance measures and inappropriate soil-tillage practices that enhance soil degradation and erosion. With the present system, the sustainability of farming in the area is at risk.

There is little hope in the short term for effective changes of the general economic and institutional frameworks within which the farmers operate. The farmers realize the need for improvements (change) but they are not in a position to make investments beyond the required level to produce the next crop. At the farm level, financial constraints

limit larger investments. The choice of options is therefore limited to measures that economize inputs and changes in practices that do not require additional investments (neither labor nor cash). There is, therefore, a need to develop an array of simple and low-cost adaptations to the present land and crop husbandry practices that could have a positive impact in the long-term.

To prevent a further degradation of the resources, soil-fertility improvement measures are needed that have long-term effects. Maize is the overall dominant crop in the area, reinforcing the dependency of the farmers on a single commodity. To reduce this dependency -and its obvious risks- diversification of agricultural production into other marketable products is desirable. Niches need to be identified that provide improved opportunities for income generation with low initial investment requirements that reduce the current dependency on the middlemen. The diversification of horticultural crops -including fruit trees-, the introduction of small livestock and the introduction of 'organic farming' products could tap growing markets in the cities.

No single technology improvement will lead to a sustainable improvement of soil fertility and yield levels. Because of their close inter-linkages, the soil (land) and crop management systems and practices need to be addressed as a whole. The study identified the following technology-development needs that are assumed key factors for the overall improvement of land productivity in the study area. However, there is no single method that can improve land productivity.

6.1 Land-husbandry options

Water conservation
Options for soil-moisture conservation and water harvesting should be explored to bridge the temporal and erratic soil-moisture shortages that occur during the dryer periods of the year, i.e., between October and February.

Appropriate mechanization
Tractors have replaced animal power to cultivate larger areas and reduce seasonal labor shortages. Some larger farmers have their own machines. Those who do not have machines hire them from others at high cost. There is a need to develop farm machinery and farm-machinery networks that are appropriate and affordable for the resource-poor farmers in the area.

Improved soil management and tillage
Contour tillage should be promoted. The type and intensity of the tillage presently practiced also destroy soil structure, and therefore have a negative effect on soil-moisture storage and nutrient-uptake efficiency. The tillage systems need to be more conservation-oriented. They need to be adapted (modified) to reduce runoff formation and improve soil structure through the incorporation of organic matter (e.g., residues, mulches, manure). This would contribute to a gradual improvement of soil fertility and stabilization of yields on a more sustainable level (Cannell and Hawes, 1994; Papendick and Parr, 1997; Reeves, 1997).

Residue management
Burning of the crop residue immediately after harvest is common. Most farmers do not know the beneficial effects of good crop-residue management on the soil quality. They need to be advised of the values of crop residue to protect the soil from erosion (i.e., as a mulch) and to improve the soil quality, and hence productivity of their fields.

6.2 Crop-husbandry options

Crop and variety diversification
Crop diversification will reduce the overall risks of production (climatic and economic) and contribute to a more ecologically balanced and sustainable use of the limited natural resources in the area. The local varieties (especially of maize) have been entirely replaced by hybrid varieties. Because farmers cannot use the seeds from their harvest of hybrid varieties for the following season, they are forced to buy new seed material each year. Local varieties, although lower in potential yield, also require lower input levels, and thus the overall net farm return may be improved. Farm-level research is needed to adapt the maize-based cropping systems to a lower input level.

Legume-based crop rotation
Legumes could contribute substantial levels of nitrogen to the succeeding crop. According to RERKASEM and RERKASEM (1994) who conducted research in northern Thailand, growing legumes, such as *Mimosa invisa* or special manure species, such as *Sesbania rostrata* during the fallow periods could easily provide 100-200 kg N ha^{-1}. These plants would also provide protective ground cover during the fallow periods, reduce runoff and soil erosion, and increase soil moisture retention (LIN, 1997). For the northeastern region of Thailand, POLTHANEE *et al.* (2002) found that mungbean residue incorporated into the soil increased pH and soil organic matter and the availability of P and K. Hence, legume-based cropping systems have potential to improve soil productivity in the area.

Optimizing the use of fertilizers
The farmers apply as much inorganic fertilizers as they can afford to increase crop yields. They do not know the required optimum application rates. Advice from the agricultural extension agencies is not readily available to the farmers.

Pest management
Farmers are increasingly facing insect and disease problems, especially in vegetables and fruit trees. They do apply pesticides, but according to the principle '*a-lot-helps-a-lot*'. They get their information from their neighbors or the companies that sell the products. The instructions on the packages do not seem to be followed. The excessive application of chemicals will have negative effects on health and the environment.
Awareness and training on the hazards of pesticide application and the proper dosages should be made a priority in agricultural extension.

Improved fruit-tree husbandry
Presently, mango trees that are between 15 and 20 years old have a very low or no production at all, although they have a high potential for production in the area, and there is a market for quality fruits. Instead, clear-cutting of the trees is common in

order to make space for other crops, such as maize and mungbean. There is a need to introduce appropriate tree-husbandry practices that enhance tree productivity.

Crop - livestock integration
Livestock raising is practiced by a few farmers only, and mainly for household consumption. Maize and other farm produce and crop residues could be used as livestock feed for a more commercially-oriented livestock enterprise that would generate additional income for the farmers. Livestock integration would also contribute to the long-term improvement of soil quality and hence productivity.

6.3 Support-services options

Effective extension service
The farmers practice agriculture by experience and they learn from their neighbors. The agricultural extension should provide services that address the real needs of the farmers in a more participatory (bottom-up) and less prescribed (top-down) way, as is currently done.

Adequate credit facilities
The smallholders are entangled in a debt cycle. In case of crop failure due to inadequate rainfall, they may even lose their assets. Options that address the capital needs of the farmers should include the setting up of saving funds and a smallholder credit scheme, facilitated by the government that minimizes the dependency on middlemen.

7 Conclusions

The land-use dynamics in the area and their driving forces are complex. The study has shown that changes in land use do not happen randomly. They are largely rooted in the economic circumstances of the time, the dependency of the land users on their limited land and capital resources and an increase in productivity needs and expectations. The different technology options outlined are apparent. However, they only address individual aspects of the land-use system and the land-management practices. Without an appropriate institutional framework that sets the foundations for investment in land and offers choices for the farmers, substantial productivity improvements that also ensure the conservation and enhancement of the land resources will most likely not materialize.

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References

Brookfield, H.; Exploring Agrodiversity; Columbia University Press, New York; 2001.
Cannell, R. Q. and Hawes, J. D.; Trends in tillage practices in relation to sustainable crop production with special reference to temperate climates; *Soil & Tillage Research*; 30:245–282; 1994.

Islam, K. R. and Weil, R. R.; Land use effects on soil quality in a tropical forest ecosystem of Bangladesh; *Agriculture, Ecosystems and Environment*; 79:9–16; 2000.

Kotto-Same, J., Woomer, P. L., Appolinaire, M. and Louis, Z.; Carbon dynamics in slash-and-burn agriculture and land-use alternatives of the humid forest zone in Cameroon; *Agriculture, Ecosystems and Environment*; 65:245–256; 1997.

LDD; Soil Education; in: *Scientific and Technology Exhibition Guide. 17th World Congress of Soil Science. 14-21 August 2002, Bangkok, Thailand*; Land Development Department (LDD), Ministry of Agriculture and Cooperatives, Bangkok, Thailand; 2002.

Lin, C. Y.; Technology for sustainable agricultural development; in: *Prospective Agricultural Technologies in Asia and the Pacific*, edited by Choudhary, M. A.; Asian Productivity Organization, Tokyo, Japan; 1997.

Nielsen, T. L. and Zoebisch, M. A.; Multi-factorial causes of land-use change: Land-use dynamics in the agropastoral village of Im Mial, northwestern Syria; *Land Degradation & Development*; 12:143–161; 2001.

Papendick, R. I. and Parr, J. F.; No-till farming: The way of the future for sustainable dryland agriculture; *Annals of Arid Zone*; 36:193–208; 1997.

Polthanee, A., Treloges, V. and Prompang, W.; Effects of fallow and mungbean residues on soil properties and yield of the succeeding corn crop in a mungbean-corn cropping systems; *Thai J. Agric. Sci.*; 35(2):137–146; 2002.

Poudel, D. D., Midmore, D. J. and West, L. T.; Farmer participatory research to minimize soil erosion on steepland vegetable systems in the Philippines; *Agriculture, Ecosystems and Environment*; 79:113–127; 2000.

Pulleman, M. M., Bouma, J., Van Essen, E. A. and Meijles, E. W.; Soil organic matter content as a function of different land use history; *Soil Sci. Soc. Am. J.*; 64:689–693; 2000.

Reeves, D. W.; The role of soil organic matter in maintaining soil quality in continuous cropping systems; *Soil & Tillage Research*; 43:131–167; 1997.

Rerkasem, K. and Rerkasem, B.; *Shifting cultivation in Thailand: Its current situation and dynamics in the context of highland development*; Forestry and Land Use Series No. 4; International Institute for Environment and Development (IIED), Chiang Mai, Thailand, London, UK; 1994.

Suwanarit, A., Lekhasoonthrakorn, N. and Rungchunag, J.; A study on green manuring technique for sustainable maize production; in: *Sustainable agriculture: Possibility and direction*; Proceedings of the 2nd Asia-Pacific Conference on Sustainable Agriculture, 18-20 October; Phitsanulok, Thailand; 1999.

Thapa, B. B., Cassel, D. K. and Garrity, D. P.; Animal powered tillage translocated soil affects nutrient dynamics and soil properties at Claveria, Philippines; *Journal of Soil and Water Conservation*; 56(1):14–21; 2001.

Zoebisch, M. A. and De Pauw, E.; Soil degradation and food security on a global scale; in: *Encyclopedia of Soil Science*, edited by Lal, R.; pages 281–286; Marcel Dekker, New York, USA; 2002.

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Improving On-farm Water Management - A Never-ending Challenge

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Abstract

Most on-farm water management (OFWM) problems are not new. They have been a threat to agriculture in many countries around the globe in the last few decades. However, these problems have now grown larger and there is increasing public demand for the development and management of land and water to be ecologically sustainable as well as economic. As there is a close interrelationship between land use and water resources, farmers need to be aware of this interrelationship and adjust their OFWM efforts in order to address the issues. In their management efforts, they need to consider both the on-site and the off-site effects.

This paper highlights holistic approaches in water management as being indispensable in the future. Present and future water-utilisation problems can only be solved on the basis of an intersectoral participatory approach to water management conducted at the level of the respective catchment area. In the context of this approach, farmers need to realise that they are part of an integral whole.

The paper also lists a range of present and future challenges facing farmers, extensionists, researchers, etc. in relation to OFWM efforts. Among the challenges are: the effects of the increasing competition for freshwater resources; the increasing influence of non-agricultural factors on farmers' land use decisions; the fragmentation of the labour process and its effects on farming skills; the information requirements of farmers; the participatory dissemination of information on OFWM; the process of changing permanently the agrarian structure; and the establishment of criteria of good and bad OFWM.

Keywords: On-farm water management, problems of on-farm water management, challenges of modern on-farm water management

Stichworte: Wassermanagement auf Farmebene, Wassermanagementprobleme, Herausforderungen eines modernen Wassermanagements

1 Introduction

Water, or the control of water, affects most crop production activities. Sufficient water must be present in the rootzone for germination, evapotranspiration, nutrient absorption by roots, root growth, and soil microbiological and chemical processes that aid in the

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decomposition of organic matter and the mineralisation of nutrients. These factors are all necessary for sustaining crop growth on a particular field. At the same time, the rootzone must be sufficiently dry to ensure adequate aeration and root growth. The rootzone must also be dry enough to allow field access for performing cultural practice activities such as planting, cultivating, fertilisation, pesticide and herbicide applications, and harvesting. Water movement through the soil is necessary in order to leach excess salts from the rootzone and so enable potential yields to be achieved. Farmers around the world are aware that farm-level land and water management practices are of prime importance for satisfying the needs of field-crop and other agricultural and horticultural ecosystems. Therefore, they endeavour to optimise the water supply of their crops within the limits of their knowledge and the farming operations practised. That is, over time, they have developed some sort of on-farm water management (OFWM) practices. However, farmers may often be unaware that conditions for the operation of farms are changing continuously. This has consequences for farm-level water management as the improvement of OFWM is a never-ending process.

This paper attempts to define OFWM, to discuss old and new OFWM problems, and to examine the challenges that farmers, extension personnel and researchers are most likely to face in the future.

2 On-farm water management, definitions and components

Water management can be defined as the planned development, distribution and use of water resources in accordance with predetermined objectives while respecting both the quantity and quality of the water resources. It is the specific control of all human interventions concerning surface and subterranean water. Every planning activity relating to water can be considered as water management in the broadest sense of the term (International Commission on Irrigation and Drainage (ICID), 2000).

Therefore, OFWM can be defined as the manipulation of water within the borders of an individual farm, a farming plot or field. For example, in canal irrigation systems, OFWM starts at the farm gate and ends at the disposal point of the drainage water to a public watercourse, open drain or sink. OFWM generally seeks to optimise soil-water-plant relationships in order to achieve a yield of desired products. The managers (farmers) usually try to achieve this desired yield by minimising inputs and maximising outputs, so as to optimise profits. In order to accomplish this, water has to be managed skilfully through certain practices covering areas of: soil and water conservation, water application, drainage, soil amelioration, and agronomy. All this has to be done within the context of the socio-economic environment of the community and the farmer's personal situation. There are a range of tools available that enable the manager (farmer) to apply these practices.

When defining OFWM, it becomes clear that the term covers not the water resources, the irrigation facilities, the laws, the farmers' institutions, the procedures and the soil and cropping systems. OFWM is concerned with how these tools and resources are used and made available to provide water for plant growth. Moreover, it encompasses all the water used for that purpose, i.e. precipitation and water applied through irriga-

tion. Furthermore, it includes the use of respective practices and tools to improve site conditions and to protect crops and farming property from excessive water (Abu-Zeid, 1979; Izuno, 1997).

In the past, extensive research work in many countries has shown that, for example, in irrigated agriculture, good OFWM practices require well-levelled fields, appropriately designed on-farm distribution systems, and a good knowledge of when to irrigate and how much water to apply. Irrigated agriculture also requires a reliable source of water, readily available when needed, and in quantities that can be distributed effectively and efficiently over the farmer's field. In addition, soil amelioration measures such as subsoiling and gypsum application may be necessary, as may a well-functioning drainage system. However, all this will lead to good OFWM only if the system as a whole is well managed, if the managers or farmers take the appropriate management decision at the right time, and if they make sure that the management decisions are indeed transferred into practice correctly and on time. Furthermore, part of the success of good OFWM depends on close communication and interaction among farmers and other water users of the respective catchment area as well as with the service providers and the water supply administration. This is especially the case if the measures taken on-site will be affected by off-site activities or will affect such activities.

3 Old and new problems

In addition to satisfying the needs of field-crop ecosystems, OFWM is of prime importance to soil and water conservation. However, field observations have shown that not all forms of OFWM are appropriate to achieving a sustainable land use while conserving soil and water. For example, differences in erosion due to different management practices of the same soil are often greater than the differences in erosion from different soils under the same management. The same applies to water where differences in water use efficiency due to different management at the same site are greater than the differences in water use efficiency at different sites under the same management. Although inappropriate management practices are an old problem in OFWM, this problem now ranks higher on the agenda as the world is faced with significant population increases, as food security becomes more of an issue and as land and water resources become scarcer.

Traditional farming systems in the tropics and subtropics often included the 'good practices'[3] of water and soil conservation. However, in many cases, increased population pressure, the introduction of new cash crops and farming systems, and the mechanisation of farming operations have led to the abandonment of these farming and conservation practices. The shift towards annual crops on steep slopes that were previously under forest, tree crops or permanent pasture has led to increased water and soil losses. Other practices such as ridge constructions, ploughing down slopes and clean weeding have created additional problems in this respect.

[3] The authors suggest the use of the term 'good practices' as being more appropriate and correct than 'best practices' as the use of the superlative indicates that the ultimate solution or practice has been found and that there is no need for further improvement. The term 'good practices' is being used increasingly and it has also been adopted by IPTRID at FAO.

Problems associated with the introduction of irrigation are: waterlogging; salinisation; soil and water contamination; and a lowering of the quality of the water released through natural or artificial drainage. Overirrigation is a common fault that together with seepage from unlined canals causes the groundwater table to rise. This leads to waterlogging and salinisation especially where there is no natural drainage or where the drainage system is inadequate. In addition, yields of crops commonly grown at the site are also reduced if the soil is compacted and soil aeration and water permeability are reduced.

Another old problem is the overuse of groundwater. The new aspect of this problem is that it has become increasingly widespread. Overexploitation leads to lower groundwater levels and increasing costs of supply, and, under certain circumstances also to subsidence, landslips, seawater intrusion, etc. All these problems have been well known to agriculture for some time. They are mostly the result of inappropriate land use decisions and/or the inability to adjust to changing circumstances. They are quite often influenced significantly by non-agricultural factors such as those of a social, economic or political nature. In many cases, political factors are more important than the technical considerations usually discussed in connection with on-farm land and water management issues.

Traditional management practices of the irrigation supply and conveyance systems often contribute to high water losses. On many farms, the low irrigation efficiency is further accentuated by farmers' traditional irrigation methods and practices, inadequate land levelling, lack of a crop-specific water application, insufficient drainage, and poor maintenance of irrigation and drainage infrastructure. Farmers are often unaware of the possibilities of applying water in a more productive way. The potential of horticultural crops with their high land, water and labour productivity is often not adequately recognised, especially by less educated and poorer farmers. Farmers generally lack technical and economic information on improved OFWM methods and techniques and on the related aspects of more productive cropping patterns and crop management. Therefore, proper training and capacity building at all levels of OFWM would be useful.

As mentioned above, these problems have been a threat to agriculture in many countries in past decades. However, these problems have now taken on an added dimension. There is increasing public demand that the development and management of land and water be ecologically sustainable as well as economically viable. As there is a close interrelationship between land use and water resources, farmers have to be aware of this interrelationship and have to adjust their OFWM efforts to address this issue. Hence, both on-site and off-site effects have to be considered in management planning and practices.

By increasing the proportion of rainfall lost due to surface runoff as a result of inappropriate land use, problems of flooding and downstream erosion arise following rain events. As less water percolates down to provide base flow for streams, the dry season flow may be lowered and even reduced to zero. Lowering of the water table can lead to the loss of well water. Decreased soil-moisture supplies result in progressively poorer vegetation. Removal of the fertile topsoil by erosion will reduce crop yields. Deposition of coarse

sand, gravel and stones removed from steep slopes onto low-lying areas decreases the agricultural potential of the soils. Sediment deposition in channels and reservoirs resulting from upstream erosion is causing major problems. Suspended sediment represents a deterioration in water quality. Fine clay particles require expensive treatment by chemical flocculation and filtration. The contamination of water resources by agriculture with harmful substances has become a widespread problem and one of increasing concern for the non-agricultural public.

Another new feature is the fact that the agriculture sector is coming under pressure to make more efficient use of water. It has been and still is criticised for being the greatest water user while having the lowest water use efficiency and lowest output per unit of water used of all sectors. In particular, irrigated agriculture, the greatest water user of all, has been accused of being responsible for inefficient water use and land degradation. In the past, agricultural research and practices dealt solely with the subject of water for the purpose of optimising water management in order to satisfy the water needs of the crop. It is only in recent times that the effects of agricultural activities on water resources have been studied in the context of intersectoral water management and have consequently become a matter of public concern. In areas of water scarcity, the competition between different sectors of water users (i.e. between agriculture, municipalities, trade, industry, nature conservation, etc.) is attracting increasing public attention. It is also clear that future agricultural practice and research will no longer be geared exclusively to the task of optimising the water supply of crops. Rather, there is a need to curb agricultural water consumption for the benefit of other sectors, for example, by reallocating water originally designated for crop production to supplying drinking-water and domestic water to the population. The challenge is clear: OFWM has to contribute to an increase in overall water use efficiency.

Finally, it is necessary to realise that the water issues of quantity and quality are not related solely to agricultural production. They are increasingly related to urbanisation and industrialisation. The migration of water from agriculture to urban and industrial uses is underway and increasing, driven by the fact that "water flows uphill towards money". Aggregate supply economics suggest that cities will gain in the long run because of the higher prices for water that urban users are more likely to pay.

4 Holistic approaches will be indispensable in the future

To date, assessments of water use efficiency have not taken account of the fate of the so-called unproductive losses, e.g. the irrigation water that seeps into the groundwater and/or flows off above ground via the drainage system. Efficiency calculations have ignored the possibility that such flows may be used by downstream water users and hence greatly improve the overall efficiency of a system. On the other hand, too little consideration has also been given to the fact that water pollution can seriously impair water use efficiency for the catchment area as a whole because polluted water will only be of limited use to downstream users.

Strictly speaking, losses in water are only unproductive if the water has irretrievably left the catchment area in either liquid or gaseous form or if it has become unfit for use.

Thus, water that runs off a farming plot or a farm area above ground or seeps into an aquifer need not necessarily be lost in the physical sense provided it can be recovered within the catchment area and reused. Therefore, in assessing water savings, it is necessary to make a distinction between 'real' and 'theoretical' savings or improvements in efficiency (SECKLER, 1996). For example, a farmer who succeeds in reducing seepage to groundwater and/or surface runoff to the drainage canal by means of water saving techniques may not necessarily be improving the water use efficiency of the catchment area as a whole, especially if the seepage water and surface runoff were previously used by downstream water users. From the overall viewpoint of water management, this example shows that there is little sense in referring water use efficiency to an arbitrarily defined irrigation area or irrigation perimeter. Instead, one should always take account of what is happening in the water catchment area as a whole. This becomes more important as water grows scarcer and as competition for the available water resource increases. Water users defending their interests within a catchment area need to realise that the present and future problems of water utilisation can only be solved on the basis of an intersectoral form of water management conducted at the level of the catchment area. Moreover, farmers need to be aware that they constitute a part of an integral whole.

In addition to quantitative losses, qualitative losses also need to be addressed and taken into consideration when looking at water losses and efficiencies of systems on various levels. Presuming that water would be passing through a system theoretically with no or only a minor decrease in quality, it is strictly speaking not lost as it may be picked up by the downstream user without any restriction concerning the quality.

As the *quantitative* water use efficiency (E_{qn}) is too narrow to provide a good judgement and estimate of the farm, system or river-basin water use efficiency, the authors suggest that the additional concept of the *qualitative* water use efficiency (E_{ql}) be introduced. This concept could be used in conjunction with the quantitative water use efficiency. This means that even if an irrigation system had a very high *quantitative* water use efficiency, as nearly all the water is being applied carefully and through modern management and irrigation practices, it may well result in a very low *qualitative* water use efficiency as all the drainage water released downstream (e.g. to maintain the leaching requirements) would be very saline or of very poor quality. With the availability of good-quality water for irrigation and for environmental needs and flows decreasing, the disposal of low-quality drainage or surplus water is becoming a critical issue. It is becoming increasingly unacceptable to dilute better quality water through low-quality drainage water. In some areas, measures have been taken to prevent natural streams from becoming the cloak of irrigated agriculture. As in the Murrumbidgee Irrigation Area in Australia, drainage water of lower quality has to be treated on-site and not disposed of to natural streams. This may be done through evaporation basins, which allow the saline drainage water to evaporate or enable it to be more viable economically while producing crops through the use of Sequential Biological Concentration systems (SBC) based on Filtration and Irrigated cropping for Land Treatment and Effluent Reuse system (FILTER), e.g. those being developed at the CSIRO in Griffith (CSIRO LAND AND WATER, 1998, 2000a,b).

5 Challenges

Within the next few decades, agriculture will face a number of important challenges. On the one hand, it is necessary to increase food and fibre production in order to guarantee food and clothing for the increasing world population. This contribution is urgently needed to help combat poverty while fostering economic development. On the other hand, agriculture will face increasing competition for decreasing water resources. The situation is exacerbated by the dwindling financial resources and increasing costs for the rehabilitation of existing irrigation and drainage systems and the setting up of new ones. Moreover, agriculture needs to meet these challenges in a political and social environment that, in many countries, is highly critical of agriculture in general and of irrigated agriculture in particular. Agriculture needs to be more sparing in its use of water resources, minimise its impact on the environment and exercise continual self-restraint by means of eco-auditing (Murray Darling Basin Commission *et al.*, 2001).

Until now, it has been farmers who have decided what happens on agricultural land. They make rational decisions according to their own circumstances. Their decisions are influenced by: physical factors, such as soil and climate; the socio-economic features of the community; and their own personal situation. Technical advice and the assistance available may be another influencing factor. As natural resources grow scarcer, the general public sees the environment as being increasingly endangered. Hence, farmers will face the challenge of land use decisions being influenced increasingly by non-agricultural factors with pressures coming from social, economic and political quarters.

Farmers cannot ignore the fact that agricultural activities produce a significant proportion of all pollutants entering streams, lakes, estuaries and groundwater. This is especially the case in Europe, North America and Australia, but it is also increasingly true in developing countries. Farmers need to admit that, in order to solve the water pollution problem, agricultural non-point source (NPS) pollution has to be controlled. They have to be aware that the solutions to controlling runoff will require an integrated effort by landowners, government and organisations responsible for protecting and restoring soil and water. Osmond *et al.* (1995) see the first step in reducing agricultural NPS pollution as being one of focusing on the primary water-quality problem within the watershed: the water-quality use impairment must be identified and the type and source of the pollutant(s) defined. Once the problem has been defined clearly and documented, the critical area, i.e. the area that contributes the majority of the pollutant to the water resource, can be identified. Land treatment, that is the installation or utilisation of good management practices (GMPs)[4] or better GMP systems, should then be implemented on these critical areas. Good and effective OFWM adjusted to the individual circumstances is an essential part of the GMP systems. For example, in some cases it might be important for farm runoff to be kept on the farm area where there is a risk of nutrient or pesticide contamination. This will require special OFWM efforts.

[4] GMPs (see footnote 3 above), often referred to as best management practices (BMPs), are practical, affordable techniques used to prevent or reduce sediment, crop nutrient or pesticide entry into surface or groundwater. GMPs conserve soil and water resources without sacrificing crop or livestock productivity

In many cases, the potential for achieving benefits from improved OFWM is substantial. Water savings, yield increases, higher productivity and higher farmer incomes are achievable. Many experiments have demonstrated a positive effect of the yields for farmers. However, in many cases, questions concerning the ability and willingness of farmers to adopt the improved practices remain. In this context, the lack of financial and economic impact assessments of various interventions and the effects of improvement measures on productivity, incomes and water use efficiency remains a major shortcoming, also for policy and strategy formulation (WOLFF and STEIN, 1999).

Water as a means for production will become increasingly scarce and expensive, making high on-farm water use efficiencies and precise water management indispensable. Furthermore, farmers may be forced to devote more attention to the sustainability of natural resources on their land and within their catchment area. This may require and prompt changes in OFWM practices. In this respect, the challenge for farmers will be to manage the water on their farms professionally in the most sustainable and profitable way. This will require detailed planning and a clear definition of the goals and the means for achieving them within the constraints given. A sound understanding of the environment and a clear commitment to sustainable OFWM practices are essential. In order to achieve all the above, it will be necessary to implement good information management and flows. In this way, it will be possible to supply the necessary information and data on which decisions should be based.

For accomplishing GMPs in OFWM, the management structure of the individual farm is quite important. This is especially the case where the labour process is becoming fragmented in the course of development. For example, in Egypt, the head of a rural household is primarily a manager, linked to other households through exchanges and the hiring of labour, rental of machinery and land, and other relationships. One of the tasks of the head of the household is to manage the labour input in agriculture. The head of the household is also usually the only household member who follows the crop through the crop cycle. The other household members and the hired labour do most of the physical work and often lack comprehensive knowledge of crop and water management. The separation of management and farm labour causes a concentration of knowledge in the person of the manager. Hence, a de-skilling of the farm labour takes place, a fact which needs to be considered when developing and implementing strategies for the introduction of advanced OFWM practices.

With generally rising income expectations and standards of living, increased agricultural yields become necessary to satisfy the higher income demand. This is why, in the course of development, land which has been regarded as fairly fertile up to this point will become marginal land, and the previously marginal land will go out of production as it may no longer guarantee the necessary yield and income levels. Agriculture and especially irrigated agriculture will concentrate increasingly on highly productive land only. More food will be produced on an even smaller area. Achieving this requires more sophisticated management of the production technologies in general, and more advanced OFWM in particular.

The implementation of a more advanced form of OFWM constitutes a major challenge for the extension service. The conventional approach of the existing extension service has often proved not to be very successful in changing farmer behaviour. This has mainly been because extension workers often have little awareness about farmers' actual needs and problems, or about the practical value of their messages with regard to the farmers' social and financial conditions. In addition, they often lack experience. New and more participatory ways for the dissemination of information in the field of OFWM seem to be needed urgently. A participatory group extension approach is currently being introduced in Egypt's extension system. It is based on the principle of learning and doing together. It seems to be the only alternative problem-solving concept conceivable for introducing a sustainable, advanced form of OFWM. Generally, it is necessary to conduct extensive education programmes in order to update continuously the knowledge base of the extension service staff and to encourage farmers to adopt good OFWM practices.

The introduction of an advanced form of OFWM also poses many challenges for the agricultural research community. For example, as not all forms of OFWM are good, there is a strong interest in establishing criteria of what constitutes good and bad OFWM. In this sense, OFWM investigations/research/projects cannot be primarily descriptive, although detailed descriptions of the management processes may be important. Instead, OFWM investigations/research/projects have to be predictive. However, the interest lies not only in predicting what a given management will do in a certain circumstance, but more fundamentally in predicting what would occur if certain activities were adopted. The outcomes of these predictions need to be evaluated and an attempt made to rank management activities in terms of better or worse and to discern the best if possible.

References

Abu-Zeid, M.; On-farm water management improvement programs; in: *Water management for arid lands in developing countries*, edited by Biswas, A. e. a.; Pergamon Press, Oxford, UK; 1979.

Izuno, F.; Principles of on-farm water management; Agricultural and Biological Engineering Department, Florida Cooperative Extension Service, University of Florida, Institute of Food and Agricultural Sciences (UF/IFAS); http://edis.ifas.ufl.edu/AE099; 1997.

CSIRO Land and Water; Evaporation basins: a salt management tool; Research project information from CSIRO Land and Water, Sheet No. 7; 1998.

CSIRO Land and Water; The FILTER system - turning effluent into an asset; Research project information from CSIRO Land and Water, Sheet No. 20; 2000a.

CSIRO Land and Water; From saline drainage to irrigated production; Research project information from CSIRO Land and Water, Sheet No. 18; 2000b.

International Commission on Irrigation and Drainage (ICID); Multilingual technical dictionary on irrigation and drainage; CD version. New Delhi, India; 2000.

Murray Darling Basin Commission, Irrigation Association of Australia and NSW Agriculture; Australian code of practice for on-farm irrigation; Irrigation Association of Australia and NSW Agriculture (http://irrigation.org.au); 2001.

Osmond, D., Spooner, J. and Line, D.; System of best management practices for controlling agricultural nonpoint source pollution: The Rural Clean Water Program Experience; RCWP Technology Transfer Fact Sheet No. 6. NCSU Water Qua lity Group, North Carolina Cooperative Extension Service, Biological and Agricultural Engineering Department, North Carolina State University, Raleigh, NC. (http://h2osparc.wq.ncsu.edu/brochures/six.html); 1995.

Seckler, D.; The new area of water resources management: from "dry" to "wet" water savings; Research Report No. 1. IIMI, Colombo, Sri Lanka; 1996.

Wolff, P. and Stein, T.-M.; Efficient and economic use of water in agriculture - possibilities and limits; *Natural Resources and Development*; 49/50:151–159; 1999.

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Hydrothermal Variations and Physio-Osmotic Conditioning Effects on Five African Millet Varieties during Short Term Substrate Desiccation

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Abstract

Environmental factors differentially affect the germination of millet (*Pennisetum americanum* L.) and impact both the rate and extent of field emergence. The extent and uniformity of emergence depends on hydrothermal variations in both soil moisture and temperature levels. To determine the impact of these two factors and counteracting physiological and osmotic conditioning seed treatments, two growth chamber trials were conducted on African millet. Five genotypes responded to differences in temperature or osmotic seed conditioning. Seed conditioning with GA_3, Kinetin, $NaCl$ and KNO_3 was tested. Increasing incubation temperature decreased the final proportion of seeds germinating and slowed germination for each of the five genotypes tested when exceeding a 29°C threshold. GA_3 improved the performance of seed lots, while physio-osmotic conditioning and temperature interacted to affect the proportion of germinating millet seeds. These germination tests partially explain interspecific differences in the impact of timing of heat fluctuations in the field. Patterns of millet germination in response to temperature and rainfall fluctuations could be explained by its response to seed conditioning, temperature or moisture levels.

Keywords: hydrothermal variations, desiccation, GA_3, *Pennisetum americanum* (L.)

1 Introduction

Osmotic priming is widely used to improve seed quality. It causes an arrest in seed germination after phase II of the triphasic pattern of water uptake, when no changes in water content occur. Major metabolic events occur at this time to prepare the seed for radicle emergence (Dewar *et al.*, 1998) and the seed is restrained from entering phase III, which includes radicle elongation and completion of germination (Garcia-Maya *et al.*, 1990). Osmotic priming of seed generally causes faster germination (Kader and Jutzi, 2001) and faster field emergence (Kader, 2001) which may result in greater mean plant dry weights, leaf areas and ground cover percentages (Posmyk *et al.*, 2001; Kader and Jutzi, 2002).

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Both higher (FINCH-SAVAGE *et al.*, 1998) and unchanged (COLBACH *et al.*, 2002) final germination percentage at reduced osmotic potential have been reported. There is a linear relationship between germination rate and hydrothermal priming time, indicating that both the external osmotic potential during priming and the duration of the priming period contribute to the improved germination rate (ALVARADO and BRADFORD, 2002). The threshold temperature at which seeds can be treated dictates the extent of the beneficial effect of osmoconditioning in alleviating drought and/or heat stress within seed. Heat-stressed seeds, however, have been found to be more responsive to hormonal applications than osmotic induction (ZHU, 2002).

This experiment was designed to investigate the influence of physio-osmotic seed conditioning with both osmotic agents and hormones on millet (*Pennisetum americanum* L.) seed response to drought and heat stress. The range of temperatures and the concentrations of hormones were based on previous work (KADER, 2001, 2002) which were effective in osmoconditioning sorghum seed.

2 Materials and Methods

2.1 Constant Incubation Temperatures

Four seed treatments including a control were applied to four millet genotypes. These included the varieties Tupatupa (Malawi), ICMV88908 (Namibia), Shibe (Tanzania) and Tuso (Zambia). All seed lots were analysed following International Seed Testing Association regulations (ISTA, 1993) and revealed 1000 seed weights of 7.9 to 13g, moisture content of 12.7 to 14.3% and viability of 98.1 to 99.6%. Seed treatments included soaking seed in 150mg gibberellic acid (GA_3) per litre, 150mg kinetin per litre, 5g KNO_3 per litre or 5g $NaCl$ per litre for 3 days (d). The control included water-soaked seeds (distilled water). All 4 seed treatments and the wet control were incubated during the 3 d period at one of six temperatures. These were 9, 14, 19, 24, 29 or 34°C in incubation chambers in the dark. After treatment, seeds were retrieved from solutions, washed in distilled water and sown in 1000cm^3 trays between germination paper. One hundred seeds were sown per tray and each treatment combination replicated 5 times. Trays were placed in a germination cabinet set at a constant 42/29°C (11hr/13hr) temperature in the dark. Germination counts were taken at 24 hour (h) intervals for 9 d and from them the final germination percentage (FGP), first day of germination (FDG), mean germination time (MGT) and germination rate index (GRI) (ESECHIE, 1994) calculated. Data were arc sine transformed (BROWN and ROTHERY, 1993) and subjected to an analysis of variance (ANOVA) with mean separation at the 5 % level of probability through Duncan's Multiple Range Test (CHEW, 1980; DAY and QUINN, 1989).

2.2 Alternating Incubation Temperatures

A dry and wet control were included in this experiment in addition to two sodium chloride-based treatments. These were 4 and 8g $NaCl$/l solutions with an osmometer-measured (Knauer, Germany) osmotic potential (Ψ_s) of -3.2 and -5.7 bar, respectively. Pearl millet PMV 3 seeds (Zimbabwe) were either untreated (dry control), soaked in

distilled water (wet control) or soaked in the $NaCl$ solutions for 3 d. Incubation temperatures during treatment included a constant 25°C regime and 3 alternate regimes. These were 25/15°C (12 h/12 h), 25/10°C and 25/5°C. Treatments were conducted in the dark. After treatment seeds were washed in distilled water and dried back at 25°C for 4 h. Batches of 100 seeds were then sown in 1000 cm^3 trays between germination paper, and 150 ml of a PEG (polyethylene glycol, molecular weight 10.000) solution (Sigma Chemical, US) producing a drought level of -10 bar added to them. Boxes were covered with lids, replicated 5 times and placed in an incubator at 44/13°C (8 h/16 h). Germination was scored daily for a period of 10 d and from the data the FGP, MGT and germination index (GI) were calculated (Benech Arnold *et al.*, 1991). At the end of the test, 16 seedlings were randomly taken from the 8 middle creases in the filter paper and their plumules and radicles excised and weighed after drying at 80°C for 4 d. These produced the dry weight of plumule (DWP), dry weight of radicle (DWR) and the plumule to radicle ratio (PRR) which is the product of DWP divided by DWR. Statistical procedures were similar to the constant incubation temperature experiment.

3 Results and Discussion

3.1 Constant Incubation Temperatures

Simple effect analysis showed that soaking treatments did not have a significant effect on the FGP or GRI of millet seed (Table 1). Germination speed as reflected by the FDG and MGT was, however, significantly increased by seed treatments in comparison to controls. GA_3 yielded lower FDG values than all other treatments excluding kinetin.

Genotypes differed significantly in their germination characteristics (Table 1). The variety Tupatupa gave the highest overall FGP and GRI pooled over treatments and incubation temperatures followed by Shibe, Tuso and ICMV88908. The slowest initiation and rate of germination were observed in Tuso as illustrated in Table 1. Incubation temperature also had a significant effect on the FGP, FDG, MGT and GRI. The 34°C incubation temperature resulted in the lowest FGP followed by 29°C, whereas the 9°C regime caused germination to initiate later and take longer time to complete. The 24°C regime was optimal in terms of this initiation and ending of germination (Table 1)

Interactive analysis of genotype and temperature effects (data not shown) revealed the same trend where 29 and 34°C reduced the FGP. Germination speed was generally increased by an increase in incubation temperature and seed treatment $\times$ genotype analysis showed no preference of a genotype to one specific treatment (data not shown). The same applied to seed treatment $\times$ incubation temperature effects, where no single treatment preferred a particular temperature.

3.2 Alternating Incubation Temperatures

Unexpectedly, the FGP of the dry control was significantly higher than that of either the wet control or the two $NaCl$ treatments. However, the MGT of the dry control was also higher meaning that it germinated slower than those seeds that were soaked

Table 1: Effect of seed treatments, genotype and incubation temperature on germination characteristics of millet

	FGP (%)	*FDG (day)*	*MGT (day)*	*GRI (%/day)*
Seed Treatments				
Dry Control	65.9 a	3.6 a	3.8 a	15.3 a
GA_3	68.6 a	3.3 b	3.4 b	16.2 a
Kinetin	64.2 a	3.5 ab	3.6 b	15.1 a
KNO_3	64.1 a	3.5 a	3.6 ab	15.4 a
$NaCl$	63.6 a	3.5 a	3.6 ab	14.4 a
Genotype				
Tupatupa	87.2 a	3.3 b	3.4 b	22.1 a
ICMV88908	45.1 d	3.4 b	3.5 b	10.3 d
Shibe	66.1 b	3.5 b	3.6 b	15.6 b
Tuso	61.0 c	3.7 a	3.8 a	13.3 c
Incubation Temp. (°C)				
9	71.5 a	3.9 a	4.0 a	14.8 ab
14	7.8 a	3.6 b	3.7 b	15.5 ab
19	70.3 a	3.4 b	3.5 b	16.0 a
24	68.2 a	3.1 c	3.2 c	17.2 a
29	58.5 b	3.4 b	3.5 c	15.2 ab
34	50.3 c	3.5 b	3.6 b	13.2 b

Means of treatment effects within columns followed by a similar letter are not significantly different according to Duncan's Multiple Range Test ($p \leq 0.05$). Same applies to means of genotype and incubation temperature effects. FGP: Final Germination Percentage, FDG: First Day of Germination, MGT: Mean Germination Time and GRI: Germination Rate Index.

(Table 2). Due to the higher FGP of the dry control it attained a higher GI value at the end of the test. The dry weight of plumules of seeds treated with the 8g $NaCl$/l solution was significantly greater than those of all other treatments (Table 2) which did not differ from each other in this respect. The DWR and PRR were not significantly different between treatments.

Incubation temperature did not have an effect on the FGP of sorghum seeds (Table 2), but affected germination speed as seen from the MGT values. The 25°C constant temperature regime gave faster germination than the 25/15°C regime. The GI was also higher at 25°C than at 25/15 or 25/10°C (Table 2). Neither DWP nor PRR were affected by incubation temperature even though the DWR was higher at 25°C than at 25/20 or 25/15°C.

Table 2: Effect of seed treatments and incubation temperatures on germination and seedling characteristics of PMV3 seeds

	FGP(%)	*MGT(day)*	*GI*	*DWP(mg)*	*DWR(mg)*	*PRR*
Seed Treatment [1]						
Dry Control	82.8 a	4.0 a	535.4 a	1.0 b	1.5 a	0.83 a
Wet Control	61.2 b	3.5 b	432.2 bc	1.3 b	1.7 a	0.88 a
4g/l $NaCl$	58.0 b	3.3 bc	401.7 c	1.1 b	1.6 a	0.75 a
8g/l $NaCl$	53.0 b	2.9 c	486.6 ab	2.0 a	2.1 a	0.97 a
Incubation Temp. (°C)						
25	68.5 a	3.1 b	521.4 a	1.4 a	2.3 a	0.64 a
25/20	64.9 a	3.3 b	476.1 ab	1.2 a	1.5 b	0.89 a
25/15	63.0 a	3.9 a	426.0 b	1.3 a	1.5 b	0.93 a
25/10	58.5 a	3.5 ab	432.5 b	1.5 a	1.6 ab	0.97 a

[1] Means of treatment effects within columns followed by a similar letter are not significantly different according to Duncan's Multiple Range Test (p(0.05). Same applies to means of incubation temperature effects. FGP: Final Germination Percentage , MGT: Mean Germination Time, GI: Germination Index, DWP: Dry Weight of Plumule, DWR: Dry Weight of Radicle, PRR: Plumule/Radicle Ratio, Dry Control: untreated seeds, and Wet Control: Water-soaked seeds.

Interactive analysis between seed treatments and temperature regimes revealed no preference of treatments for a certain temperature but a tendency of water-soaked seeds to perform better under the 25°C regime than under others (data not shown).

A constant temperature during seed soaking appears to be more favourable for post-treatment germination than an alternating one. Generally, a rise in incubation temperature during treatment increased post-treatment germination speed which agrees with the data of Khan *et al.* (1980) who obtained higher germination rates at 20°C in comparison to 10 or 15°C. However, no effect on the FGP was detected. This means that if a threshold temperature is reached, certain changes may occur within the seed that are dependent on future temperatures. Lima bean (*Phaseolus lunatus* L.) seeds imbibed at 15°C and then allowed to germinate and grow at 25°C have been shown to produce smaller seedlings (Pollock and Toole, 1966), which has been linked to preferred temperature ranges during soaking (Kader and Jutzi, 2002). Hegarty (1978) concluded that reduced seed response after soaking at 10 or 30°C compared to 20°C is associated with greater losses of solutes from the seeds. Seeds, in this experiment, were dried back after treatment and it has been reported that embryos imbibed for 60 minutes, dried and returned to water again show a rapid leakage of solutes (Bewley and Black, 1978a; Winiewski and Zagdaska, 2002). This may be one of the reasons why dry controls gave higher FGP values. Imbibition at the higher temperature range also increases sensitivity to ethylene (Zarnstorff *et al.*, 1994) which may explain reduced

FGP values. Also, at 30°C cytokinin passage from the cotyledon to the embryonic axis is affected (Eloisa Revilla *et al.*, 1988). Hassan *et al.* (1985) observed decreased auxin concentrations with time in seeds of *Anemone coronaria* and *Ranunculus asiaticus* at 8°C compared with 24°C during soaking. This may have caused the increased MGT values observed under lower incubation temperatures.

That an increase in soaking temperature reduced the MGT is in agreement with the results of Hardegree (1994) and Argerich and Bradford (1989) who showed increases in germination rate with rises in temperature up to 25°C. Khan *et al.* (1978) found that osmoconditioning celery seeds at 15°C was not as effective as at 20°C in shortening germination period. Pollock and Toole (1966), reported an immediate imbibitional uptake of water at 25°C for about 2 h, a lag period for the 2^{nd} to the 6^{th} h, and, finally, a rapid, linear uptake to about the 25^{th} h. Both the duration of the lag phase and the second rapid uptake phase were dependent on imbibition temperature. Imbibition at lower temperatures (5 or 15°C vs. 25°C) lengthened the lag phase. Additionally, higher temperatures may have reduced water viscosity surrounding the seed and, thus, increased its diffusion (Woodstock, 1988). Vertucci and Leopold (1983) suggested two components of early imbibition: An initial wetting reaction which is influenced by the surface tension of the water and a subsequent flow of water through seed tissue which is influenced by water viscosity.

The effect of soaking treatments on the germination and early axis growth of seedlings may not be attributed to the osmotic potential (Ψ_s) of solutions which would decrease water uptake as it drops (Gurmu and Naylor, 1991; Leubner-Metzger *et al.*, 1996), but rather to possible physiological or ionic effects. The Ψ_s of 4g $NaCl$/l and 8g $NaCl$/l solutions were -3.2 and -5.7 bar. Hence, differences were not large in the Ψ_s between treatments and it is, thus, difficult to trace back results to this factor, which would typically arise from notable differences in Ψ_s (Hadas and Russo, 1974). The greatest increase in germination speed in the constant temperature experiment was in the GA_3 treatment. The production of gibberellin is speculated to be a prerequisite for radicle emergence (Bewley and Black, 1978a; Dewar *et al.*, 1998). Additionally, cell extension of plant tissue is generally held to be regulated by hormones, especially auxins and gibberellins (Agu *et al.*, 1993; Rood, 1995). Since germination culminates in radicle emergence, which in most cases comprises only cell enlargement and not necessarily cell division (Bewley and Black, 1978b), the promotive role of GA_3 in increasing germination speed is not surprising. Exogenous application of GA_3 has been reported to stimulate growth (Kozlowski, 1972; Bewley, 1995; Steinbach *et al.*, 1997) and germination percentages and rates in sorghum seeds soaked for 4-6 days in 500 or 750 ppm GA_3 at 15 and 20°C (Santipracha, 1986; Kader, 2001).

References

Agu, R., Nwufo, B., Ude, S. and Onwumelu, A.; Influence of gibberellic acid (GA3) on diastase and cellulase development of Nigerian millet (*Pennisetum maiwa*) and sorghum (*Sorghum bicolor*); *Process Biochemistry*; 28:105–108; 1993.

Alvarado, V. and Bradford, J.; A hydrothermal time model explains the cardinal temperatures for seed germination; *Plant, Cell and Environment*; 25:1061–1069; 2002.

Argerich, C. and Bradford, K.; The effects of priming and ageing on seed vigour in tomato; *Journal of Experimental Botany*; 40:599–607; 1989.

Benech Arnold, R., Fenner, M. and Edwards, P.; Changes in germinability, ABA content and ABA embryonic sensitivity in developing seeds of *Sorghum bicolor* (L.) Moench induced by water stress during grain filling; *New Phytologist*; 118:339–347; 1991.

Bewley, J.; Physiological aspects of desiccation tolerance: a retrospect; *International Journal of Plant Sciences*; 156:393–403; 1995.

Bewley, J. and Black, M.; *Physiology and Biochemistry of Seeds*; vol. 1; Springer-Verlag, Heidelberg; 1978a.

Bewley, J. and Black, M.; *Physiology and Biochemistry of Seeds*; vol. 2; Springer-Verlag, Heidelberg; 1978b.

Brown, D. and Rothery, P.; *Models in Biology: Mathematics, statistics and computing*; Wiley & Sons, London; 1993.

Chew, V.; Testing differences among means: correct interpretation and some alternatives; *Hortscience*; 15:467–470; 1980.

Colbach, N., Chauvel, B., Duerr, C. and Richard, G.; Effect of environmental conditions on *Alopecurus myosuroides* germination. 1. Effect of temperature and light; *Weed Research*; 42:210–221; 2002.

Day, R. and Quinn, G.; Comparisons of treatments after an analysis of variance in ecology; *Ecological Monographs*; 59:433–463; 1989.

Dewar, J., Taylor, J. and Berjak, P.; Changes in selected plant growth regulators during germination in sorghum; *Seed Science Research*; 8:1–18; 1998.

Eloisa Revilla, M., Martin, L., Nicolas, G., Estrella Legaz, M. and Villalobos, N.; Effects of high temperature on the variation and transport of endogenous cytokinins during the germination of chickpea seeds; *Journal of Plant Physiology*; 132:223–228; 1988.

Esechie, H.; Interaction of salinity and temperature on the germination of sorghum; *Journal of Agronomy and Crop Science*; 172:194–199; 1994.

Finch-Savage, W., Steckel, J. and Phelps, K.; Germination and post-germination growth to carrot seedling emergence: predictive threshold models and sources of variation between sowing occasions; *New Phytologist*; 139:505–516; 1998.

Garcia-Maya, M., Chapman, J. and Black, M.; Regulation of α-amylase formation and gene expression in the developing wheat embryo. Role of abscisic acid, the osmotic environment and gibberellin; *Planta*; 181:296–303; 1990.

Gurmu, M. and Naylor, R.; Effects of low water availability on germination of two Sorghum cultivars; *Seed Science and Technology*; 19:373–383; 1991.

Hadas, A. and Russo, D.; Water uptake by seeds as affected by water stress, capillary conductivity, and seed-soil water contact. 1. Experimental study; *Agronomy Journal*; 66:643–647; 1974.

HARDEGREE, S.; Matric priming increases germination rate of great basin native perennial grasses; *Agronomy Journal*; 86:289–293; 1994.

HASSAN, H., AGINA, E., BAZ, I. and MOHAMED, S.; Some physiological studies on seed germination of some ornamental plants; *Annals of Agricultural Science*; 22:617–630; 1985.

HEGARTY, T.; The physiology of seed hydration and dehydration, and the relation between water stress and the control of germination: a review; *Plant, Cell and Environment*; 1:101–119; 1978.

ISTA; International rules for seed testing; *Seed Science and Technology*; 21; 1993.

KADER, M.; Heat shock events, inhibition of seed germination and the role of growth regulators in stress alleviation; *Journal of the Royal Society of New South Wales*; 134:79–88; 2001.

KADER, M.; Physiological modification of stress: Exogenous GA_3 applications to seed; in: *Proceedings of the 5^{th} Australian Horticultural Conference*; page 21; Sydney, Australia; 2002.

KADER, M. and JUTZI, S.; Drought, heat and combined stresses and the associated germination of two sorghum varieties osmotically primed with NaCl; *Phytogen*; 3:22–24; 2001.

KADER, M. and JUTZI, S.; Temperature, osmotic pressure and seed treatments influence imbibition rates in sorghum seeds; *Journal of Agronomy and Crop Science*; 188:286–290; 2002.

KHAN, A., KAR-LING, T., KNYPL, J. and BORKOWSKA, B.; Osmotic conditioning of seeds: Physiological and biochemical changes; *Acta Horticulturae*; 83:267–278; 1978.

KHAN, A., PECK, N. and SAMIMY, C.; Seed osmoconditioning: Physiological and biochemical changes; *Israel Journal of Botany*; 29:133–144; 1980.

KOZLOWSKI, T.; *Seed Biology*; vol. 2; Academic Press, New York; 1972.

LEUBNER-METZGER, G., FRÜNDT, C. and MEINS JR., F.; Effects of gibberellins, darkness and osmotica on endosperm rupture and class I b-1,3-glucanase induction in tobacco seed germination; *Planta*; 199:282–288; 1996.

POLLOCK, B. and TOOLE, V.; Imbibition period as the critical temperature sensitive stage in germination of Lima bean seeds; *Plant Physiology*; 41:221–229; 1966.

POSMYK, M., CORBINEAU, F., VINEL, D., BAILLY, C. and COME, D.; Osmoconditioning reduces physiological and biochemical damage induced by chilling in soybean seeds; *Physiologia Plantarum*; 111:473–482; 2001.

ROOD, S.; Heterosis and the metabolism of gibberellin A_{20} in sorghum; *Plant Growth Regulation*; 16:271–278; 1995.

SANTIPRACHA, Q.; Improvement of sorghum seed germination and emergence under stress conditions by seed treatments; *Dissertation Abstracts International, B. Sciences and Engineering*; 47:862 b; 1986.

STEINBACH, H., BENECH-ARNOLD, R. and SANCHEZ, R.; Hormonal regulation of dormancy in developing sorghum seeds; *Plant Physiology*; 113:149–154; 1997.

VERTUCCI, C. and LEOPOLD, A.; Dynamics of imbibition of soybean embryos; *Plant Physiology*; 72:90–193; 1983.

Winiewski, K. and Zagdaska, B.; Genotype-dependent proteolytic response of spring wheat to water deficiency; *Journal of Experimental Botany*; 52:1455–1463; 2002.

Woodstock, L.; Seed imbibition: A critical period for successful germination; *Journal of Seed Technology*; 12:1–15; 1988.

Zarnstorff, M., Keys, R. and Chamblee, D.; Growth regulator and seed storage effects on switchgrass germination; *Agronomy Journal*; 86:667–672; 1994.

Zhu, J.; Salt and drought stress signal transduction in plants; *Annual Review of Plant Biology*; 53:247–273; 2002.

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Poverty, Land Resource Management and Gender Participation in Libokemkem District of Northern Ethiopia.

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Abstract

High population pressure and land degradation are threats of food security in the highlands of Ethiopia. Poverty and food insecurity are closely related phenomena. Both of them compel poor farmers to practice unwise use and resource management, which lead to low resource productivity. This study examines the various factors determining poverty and resource management at a household level with gender perspective in Libokemekem district of Ethiopia. Farm level diversification of crops and mitigating food insecurity is highly constrained due to lack of farm resources principally limited land size. Consequently, households with large family sizes and limited resources are vulnerable to food insecurity. Although households practice various coping mechanisms and alternative resource management strategies, they are not sufficient to curb household food security. The magnitude however, varies between female and male-headed households. Socioeconomic factors such as age, soil type, farm size, sex of household heads, area under rice production, number of oxen, and slope of the land are among the major factors to influence and discriminate between female and male-headed households. This study concludes by highlighting and indicating possible direction for policy intervention in view of enhancing food security and sustainable resource management.

Keywords: resource management, poverty, gender, Ethiopia

1 Introduction

Land degradation is one of the major threats in the Ethiopian highlands where intensive cultivation is practiced. More than 88% of the Ethiopian 65 million people are engaged in agriculture, and livestock stocking rates are the highest of any agro-ecological zone in sub-Saharan Africa (Omiti *et al.*, 1999). This pressure appears to continue in the face of growing population and it has resulted in accelerated rates of natural resources degradation that is of major concern. The principal environmental problems of soil erosion, gully formation, continuous loss in soil fertility and severe soil moisture stress are partly the result of loss in soil depth and organic matter. As a matter of fact, the massive soil loss is perhaps the country's largest export. Soil erosion and land degradation in general contribute to variations in output and affect household food security.

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The Libokemkem district of South Gondar zone (Figure 1) shares some of the common features of environmental degradation (largely in the forms of deforestation and soil erosion) taking place in the country. The area is basically characterized by low road density and limited access to market outlet, lower agricultural technology intervention and less institutional services. The population is increasing and this creates extra pressure on the land, thus leading to increased poverty.

On the other hand, concerted efforts and measures have been taking place to redress the prevailing development bottlenecks. Some of these measures include physical management of natural resources such as construction of stone terraces, soil bunds, area enclosure and tree planting; these have been supported by policy measures. Following the 1991 reforms, new economic policies were introduced to address issues related to landownership, liberalization of input and output markets, conservation of natural resources and other incentives to make the farming community responsive to economic reform and improved technologies. However, the interventions and impacts seem to have different forms and scales in different regions of the country. With a transition towards a market based economy many households might be engaging in practices that could restore or maintain soil fertility. Soil conservation measures of planting trees, crop rotations, applying organic and inorganic fertilizers are also some of the support measures, which are visible around the farming communities. These interventions might have gender implications at the household level. As the population increases, demand for fuel wood increases, and as commercialization increases more opportunities for markets would be opened up. Farmers switch to different economic activities responding and adjusting to market operation and policy incentives.

Time spent on management of resources reasonably changes between households and even with gender composition (women, children and men). The policy measures taken after 1991 have regional dimension and further implication on equity. Autonomous rights were given to regions for internal administration and policy implementation. In Amhara National Regional State, the redistribution of land has taken place in 1997, deepening the reform as an equity measure between males and females. Consequently, many women households have access to land irrespective of size and quality. It is recognized that the measures would show positive impacts in the long run if they also result in poverty alleviation and sustainable resource management.

The objectives of this study were to examine the state of poverty as related to food security and farm level resource management in the district, and identify determinants of household poverty and resource management and gender differentials.

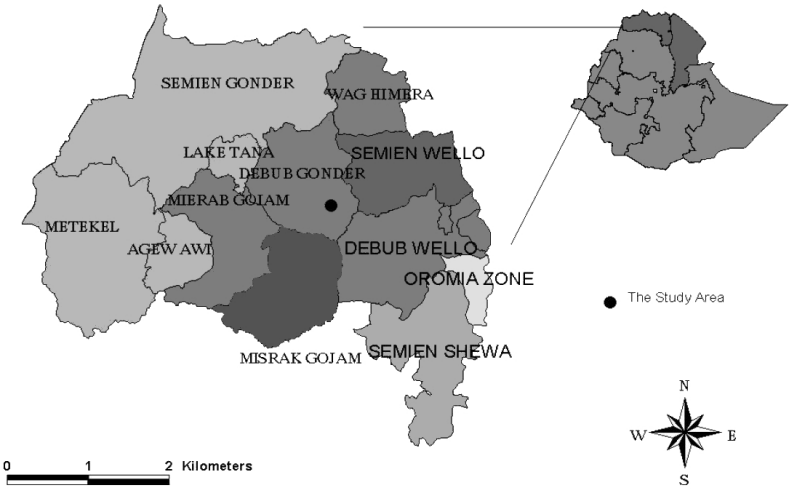
2 Methodology

2.1 Choice of the study area

Libokemkem district was deliberately chosen among other districts because it is one of the five food insecure districts of the zone, characterized by low road density and limited access to markets, inadequate technological intervention with continuous land degradation, food insecurity and various coping mechanisms to food security. The total

population of the district is about 160,603 (information obtained from Libokemkem district council) of which 90% are living in rural areas and engaged in farming activities. The illiteracy rate is alarmingly high.

Figure 1: Location of the study area.



(Source: Atlas of Amhara Regional State, Ethiopia)

2.2 Sample selection

The study was conducted in June 2000/2001. The initial step in data collection was to obtain household level information thereby incorporating gender in the study. 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 from each *Limat tabias* (development centers), depend on the number of male and female households (n_i) and standard deviation of major variables. A total of 150 farm households were selected of which 94 were male and 56 were female-headed households. 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. Details of methodologies followed are given in a seperate report (Winrock International Ethiopia, 2000).

Non-parametric and descriptive statistics and frequency analysis, ratios and partial analysis were employed to describe changes in resource management perceptions. Probit response model was employed to examine factors responsible for management of resources. In addition discriminant analysis was employed to capture factors responsible for food security differences between male and female-headed households (Maddalla, 1983).

3 Results and discussion

3.1 Poverty and household food security

The definition and classification of poverty is one of the controversial and inconsistent concepts. Nevertheless, the conventional definition of the poor refers to those persons who subsist below a level of income that can sustain only a bare minimum standard of living (Dércon and Krishman, 1994). In this connection poverty can be related to various concepts of income such as very low level of food self-sufficiency and low purchasing power. Food availability situation in the district indicates that food availability and food self-sufficiency ratio was at a level of 75% in 1994/95 and the same ratio raised to 80% in 1996/97 (South Gondar Administrative Zone, 1997). This evidence shows that there is still food deficit to match the demands for food. Analysis of the household level baseline survey data showed that low agricultural productivity and food insecurity are the results of many factors, which are many and probably interwoven. The causes can be grossly attributed to low level of land resource management, which lead to low agricultural productivity, access to resources, limited off-farm activities and poor infrastructure development. In Libokemekem district, it is generally hypothesized that the level of poverty is specifically related to farm resources such as oxen, land size, access to credit and infrastructure, although, the problems may vary from one household to another.

The measurement of poverty and analysis of food security by itself is a difficult task. As a result this study outlines the poverty in terms of proxy variables in relation to the condition of the household, without direct measurement of the level of poverty. The main purpose of this exercise is not to indicate the correlates of poverty but rather to argue that on both theoretical and empirical grounds there are numerous pitfalls in defining poverty in a single dimension-using variable related to gender differentiated households.

To this effect, a variable related to gender-differentiated farmers' classification of poverty has been used as a benchmark to show poverty at the household level. During the PRA survey farmers used farm size, number of oxen, area allocated for teff (*Eragrostis tef*) as a surrogate for wealth status. Those farmers having less than 0.5 hectares of land and with one or no ox were classified as extremely poor farmers and these groups are vulnerable to food poverty. Having such poverty indicators, an average household has less than one hectare of land with an average family size of 5 and some oxen or no ox while 30% of households have less than 0.5 hectares of land.

3.2 Diversification of crop production

The main crops for diversification are limited to few crops like teff, wheat and chickpea and lentil. Some horticultural crops like potatoes are commonly used as catch crops. The diversification is therefore limited. The risk is also high since farmers have a limited option for diversification. The major problem for diversification of crops is not lack of crop varieties but rather a limited land size often not more than a hectare of land.

On the outset, a household may allocate his/her land to various crops grown in the area to optimise the limited resources. If the land size tends to be a limiting factor, a farm household gives priority to the most preferential crop. That means he/she would allocate land either to teff or wheat based on their priority without much of diversification. Even those who have access to diversification use limited improved technology and hence productivity per unit area is very low for the preferred crops. This clearly shows that those farmers especially those having below a hectare of land and with no access to diversification are susceptible to food insecurity even with optimum use of the available technology. Crop diversification option is limited usually to one or two major crops and even worse for those farm households with an average family size of 5 and having less than 0.5 hectares of land (Table 1).

Table 1: The level of crop diversification by sex differentials in Libokemkem district, Ethiopia

		Sex of head	
Crop types	*Farm size in ha*	*Male (N)*	*Female (N)*
Teff	0	42	26
	0.12-0.37	26	15
	0.5-0.75	24	14
Wheat	0	30	24
	0.12-0.75	61	29
	1	0	2
Chickpea	0	72	42
	0.12-0.25	21	11
Potatoes	0	93	52
	0.12	1	3

Source: survey result

3.3 Food availability

The level of household consumption at anyone year is determined by what the household has initially produced and how much of the produce it has given away to meet its obligation. On a limited land the household consumption is very much limited to the

capacity of production to a limited crop with in a specific period usually one year. In addition, the crops produced and available for household consumption at anyone time may vary from one year to another due to unpredictable rainfall or weather change and hence consumption levels are not uniform throughout the year. Under normal years, there is enough food from end of November to May. The months of food availability often coincide during normal years with the time of harvesting, threshing and grain storage activities.

The months of June, July and August partly September and October are months of food shortages. Even the relatively food surplus seasons are crowded with cultural and religious festivals and weddings. This, though, has to do with social and cultural taboos, too much food is wasted which otherwise would be used for the family household consumption. Although these occasions seem to be temporary, some farmers sell their animals, while others take loan from local moneylenders with high interest rate to smooth out the food shortage. Under worst condition, some sell their assets to cope up with the food deficit. Table 2 shows that nearly all households employ more than one copping strategy to alleviate food shortages. Borrowing is the most common strategy employed

Table 2: Coping mechanisms in % by sex of households in Libokemkem district, Ethiopia

Mechanisms of indicators	*Male*	*Female*	*Total*
Borrowing	36	16.7	53.6
Aid	3.6	3.6	7.1
Gift	7.1	3.6	10.7
Selling assets	11.9	8.3	20.2
Off-farm	-	8.0	8.3

Source: survey data

by most of the households. Most households resort to informal credit since consumption credit is not available in the formal credit. Informal credit may take different forms mainly in kind. Credit in kind often includes grain and is usually paid back in equivalent doubling the amount borrowed. Such type of credit is usually easily available for borrowing and the transaction cost is very low for the borrower. Surprisingly enough, off-farm activities are one of the mechanisms employed by female households rather than male, although no statistically significant difference was observed. Females have more diverse opportunities than male and engage themselves in weaving, making local brewery etc, and use the income generated to overcome food insecurity. Most of the food insecurity is often transitional.

This variability in income affects the poor more than others. Obviously, women are the most vulnerable group, who are affected by the phenomenon, since it is they who are the majority falling in that category. Even those who have sufficient land but not oxen, have to arrange sharecropping or ox renting and hired labor. Whether this feature has

significant differential effects between male and female-headed households was examined using discriminate analysis based on hypothesized variables as shown in Table 3.

Table 3: Standardised canonical discriminant and classification functions *

Variables	*Canonical coefficients* †	*Coefficients/ linear discriminant Classification functions*	
		Male	*Female*
Number of oxen	0.688	2.25	1.65
Family size	0.579	0.117	0.026
Farm size (ha)	0.363	6.07	5.84
Priority of education (male/female)	-0.246	4.426	4.80
Fertility of the soil	0.187	2.78	2.15
Slope of the land	0.153	0.11	-.184
Black soil availability	0.057	17.46	17.9

* 66.4 % of original "grouped" cases correctly classified

† prior probability for each group is .500

Table 4: Summary of canonical discriminant functions

Eigen values	0.18
Cannonical correlation	0.39
Wilk's Lambda	0.842
Chi-square	23.15
Df	6.0
Significance	0.003

3.4 Factors influencing household poverty

It was assumed that since household food security is gender sensitive, about seven variables were hypothesized to influence the level of poverty and hence household level food security to discriminate between male-headed and female-headed households. Soil type (Black soil), fertility of the soil, slope of the land is considered as proxy for the availability of sufficient land to produce enough food. These factors tend to measure the physical quality aspect of the land. In addition to the physical factors related to land, number of oxen owned and farm size were considered as surrogate for wealth status while family size and priority given to education for male and female were considered in the household as proxy for human capital.

The result showed that the three variables, namely; number of oxen, family size and farm size discriminate level of poverty significantly between female and male headed households (Table 3). The remaining variables (as shown in the order of importance), priority of education (male/female) within the household, fertility of the soil, slope of the land and the availability of black soil discriminate poverty between male and female-headed households. The classification result shows that more than 66% of the group was correctly classified between the female and male-headed households.

Although the farm size, as it has been hypothesized, is an important factor of production, it should be combined with a pair of oxen to play a significant role. Nevertheless, most of the households have one or no oxen. This situation is worse with female-headed households than with males. Equity in distribution of land between male and female-headed households was not compensated by higher productivity due to lack of inputs. From the equation it is evident that the intensification of poverty, a case not unique to Libokemkem, has been largely attributed to shortages of resources in relation to the population pressure. The increasing shortage of land and other resources means greater male and female dependency in the household. Those who reach working age and want to marry do not have access to land and hence they remain dependent. Women are more vulnerable as they have to stay with the family and priority is often given to males in the household. The type of farmland as indicated by black soil type, fertility and slope of the land describes the quality of the farmland and hence clearly explains the differences in resource endowment between male and female-headed households.

3.5 Farm resource endowment and land resource management

The average family size is 5.5 in male-headed households as against 4.4 in female-headed households. The variability is however, very high within female-headed 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 to various crops), grazing area, forest, and unused area. The allocation of farmland to various crops depends on the priority of crops in the household (Table 5). 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 redistribution. The decrease in average land size holding, on the other hand, might probably be due to distribution and redistribution of land, which took place in the region. Distributional effect also resulted in various forms of tenure arrangement to acquire extra land, and is not however, the subject to be discussed in this paper.

Beside limited farmland, more than 80% of the farmers are aware of and perceived soil erosion problems as an important economic problem in constraining the productivity of the land. The effects of soil erosion were also perceived as major causes for the reduction in crop and pasture yield. As a result, many farmers at the household level have taken different forms of land conservation measures. The level of participation appears to have

Table 5: Average farmland holdings for various crops in Libokemekem district, Ethiopia

Resource category	*Male -headed (Area in ha)*	*Female headed (Area in ha)*	*Total*
Farm size	1	0.8	0.93
Wheat	0.33	0.34	0.33
Teff	0.41	0.38	0.40
Chickpea	0.31	0.28	0.30
Lentil	0.32	0.25	0.29
Rice	0.40	0.33	0.35
Potato	0.12	0.33	0.35

Source: Survey result

some forms of gender dimension.

According to the survey results, 58% of the male-headed households practice contour

Table 6: Soil and water conservation practices by sex difference in Libokemekem district, Ethiopia

Practices of soil and Water conservation	*Male (%)*	*Female (%)*	*Total*
Contour ploughing	58	64	60
Criss-cross ploughing	42	35	36
Flood control	9.7	2	6.8
Terracing	52	47	51
Check dams	43	30	38
Intercropping	9.7	13	11

ploughing while 64% of the female-headed households including those female household members practice the same (Table 6). Some 41% of the male farmers practice traditional soil conservation practice as against 35% in female-headed households. Close to 70% of the total sampled farmers perceived the practice as useful practice to control soil erosion and in this case contour ploughing is considered as the major control measure against soil erosion by the majority of farmers. In addition, 53% and 47% of the male and female-headed farmers respectively considered terracing as effective measure of soil and water conservation although it demands more labor. The major impediments to soil and water conservation measures, in general are lack of labor and willingness of the farmers to collaborate in terrace making. Labor shortage particularly is the most serious constraint within women-headed households.

3.6 Maintaining soil fertility

The dominant soils in the area are traditionally classified as brown soils. They are susceptible to erosion. The farmers perceived that due to continuous ploughing and soil erosion, the characteristics of the soils have changed and hence one finds predominantly less fertile soil at the top. As a result farmers use different mechanisms (a combination of indigenous and modern techniques) of soil fertility improvement. These techniques vary between households depending on land size, type of land and availability of labor. As shown in Table 7, the most commonly known practices include inter-cropping, com-

Table 7: Soil fertility maintenance as practiced by farmers (% respondents) in Libokemkem district, Ethiopia

	Head of household		
Types of practice	*Male*	*Female*	*Whole sample*
Inter-cropping	9.7	13.2	11
Compost	10.7	9.4	10
Animal dung (manure)	45.2	28.3	39
Crop rotation	91.4	92.5	91.8
Fallow	3.2	–	2.1

Source: survey result

post making and application on farm land, use of animal dung, crop rotation and fallowing. Crop rotation is the dominant practice followed by application of animal dung. About 90% of the farm households use crop rotations to improve the fertility of the soil. Crop rotation practices in general involve alternative combinations of cereals, legumes and rotational fallow within a 2-3 years cycle. They do not have definite rotational practice except they combine their indigenous knowledge of the farming systems with the environment and grow different mix of local varieties. This practice is almost equally applied between male and female-headed households. Only some 3% of the male households leave some of their land under fallow. Due to the population pressure (as in the central highlands of Ethiopia) and the consequent decline in farmland, fallowing practice is declining from time to time.

Female-headed households apply less animal dung as farm manure than males. Probably female-headed households tend to sell animal dung in the market and own less number of livestock than the male counterparts. Animal dung as organic fertilizer is more applied in the backyards compared to the farmlands located in a far distant area. On the other hand, it is often observed that the application of inorganic fertilizer is limited and often depends on the household's purchasing power and crop types grown. In fact, the limited number of farmers who use fertilizer apply sub-optimal level, as against recommended levels. Nevertheless, recent development in the area shows that there is a tendency of increased use of fertilizer. Fertilizers are often applied on most preferred crops like teff, rice, and wheat and to a lesser extent on pulses. The reasons for low use of inorganic

fertilizers include lack of purchasing power, non-availability of fertilizer at planting time, unpredictable weather, and use of alternative methods of maintaining soil fertility.

3.7 Afforestation

Although the effective area under forest is not known with certainty, deforestation and de-vegetation in the past have certainly contributed to severe soil erosion and low agricultural output. Nevertheless, this situation appears to be changing after the transition from collectivization of agriculture towards liberalized and private ownership. As a matter of fact, tree-growing status appears to be changing in response to the demand for fuel wood, construction wood, and other wood products in rural areas. The establishment of fuel wood projects played an important role in planting trees on private farmland (woodlots), farm boundaries and gardens in the area. More than 80% of the farmers have a tendency to expand tree planting for marketing, fuel wood, farm boarder fencing, animal feed and to a lesser extent to control erosion.

The most common species planted include *Eucalyptus globulus*, *Acacia albida*, and sesbania. Nevertheless, *Eucalyptus globulus* is the most dominant and fast growing species preferred by almost 100% of both female and male farmers for marketing, fuelwood and construction purposes. Eucalyptus serves as a cash crop and the planting has increased on woodlot. Some farmers even grow it on agricultural land for marketing. The justification is that they get better returns from growing trees than from crop, due to the opening up of markets far distant in the north. Nevertheless, they have got different management systems. Some use very dense (less than 30 cm) spacing, while some go up to 1 meter spacing. This management practice will clearly have an effect on the final harvesting and sale of forest assortment.

The farmers sell the products from eucalyptus in various assortments. They sell it as pole (*quami*), fuel wood and *atena* (thinner logs used for fencing). The price for pole commands higher market value than for fuel wood. Most farmers harvest the poles from the seedling stands after four years and second rotation from coppice stand after 3-4 years. Farmers with relatively large size of farm would like to allocate their land for tree planting compared to farmers with smaller size of farmland who would like to grow more crops and plant trees on farm boundaries. Although, the economic returns from planting trees seems to be attractive, because of the long-term benefit, farmers with limited resources allocate their land to crop production. Hence, in general poor farmers, particularly the women group plant less trees on their farmland. This situation clearly shows the need for intervention in the area of policy-oriented action in tree planting and development.

3.8 Determinants of land resource management

There are various factors affecting the management of resources at the household level. The mean values of the variables hypothesised to affect the land resource management (conservation measure) are shown in Table 8. These are age, soil type, farm size, sex of household, area under rice production, number of oxen, and slope of the land.

To see the effect of various factors on the adoption of conservation measures response

Table 8: Description of mean values of variable(s) in the analysis

Variable	*Description*	*N*	*Mean*	*Standard deviation*
AGEHEAD	Age of the head	149	39.97	10.00
BLAKSOIL	Have black soil	149	1.79	0.40
FARMSIZE	Farm size, ha	146	0.93	0.58
FAMLYSIZ	Total family size	146	5.17	2.00
REDSOIL	Have red soil	146	1.44	0.49
SEXHEAD	Sex of the head	149	1.37	0.48
RICEAREA	Area covered with rice, ha	149	0.005	0.45
NUMOXEN	Number of oxen owned	149	0.97	0.87
SLOPE	Slope of the land	149	1.58	0.70
SHTREFIR	Is there shortage of fire wood	149	1.18	0.39

models were fitted into the equation. conservation practice here considered as dependent variable is a combination of contour ploughing practice and agroforestry. These variables were found to be the dominant practices during the survey. The inverse-mills ratio, φ, which measures the probability of the household being an adopter, is used to address self-selection bias that may result, since adoption of agro-forestry and conservation was a voluntary choice exercised by farm households (Pattanayak and Mercer, 1998). Since data exists for non-adopters, it is not a matter of concern to the sample selection problem, which requires truncated regression. The probability of adoption can be specified as:

$$\varphi = \frac{\psi(\gamma'' \kappa)}{1 - \delta(\alpha' \kappa)}$$

Where κ is a vector of socioeconomic characteristics which explain the adoption decision, and ψ and δ are the probability density and cumulative distribution of the error term, respectively.

Out of the ten variables hypothesized to affect the probability of adoption of conservation measures, seven of them are found to significantly affect the decision (Table 9). Age of the household affects the decision of conservation negatively and significantly. This shows that older people undertake less conservation activities compared to the younger generation. This might be related to attitudinal changes and the availability of labor required for conservation. The availability of rice area within the household farm affects conservation positively. Rice production in the study area is getting increasingly more attention from time to time, although it demands capital and labor. Those farm operators with relatively larger area allocated to rice production give more attention to conserve the soil. Shortage of firewood also seems to compel farmers to use the practice for planting more trees, which also lead to conservation measure.

Table 9: Probit model of soil and water conservation adoption

	variables in the equation						
Variable	*B*	*S.E.*	*Wald*	*df*	*Sig.*	*R*	*Exp(B)*
AGEHEAD	-.0428*	.0221	3.7715	1	.0521	-.0959	.9581
BLAKSOIL	-1.5578*	.6631	5.5194	1	.0188	-.1352	.2106
FARMSIZE	-.5763	.5901	.9536	1	.3288	.0000	.5620
FAMLYSIZ	-.2075**	.1116	3.4560	1	.0630	-.0869	.8126
REDSOIL	-.1817	.5215	.1214	1	.7275	.0000	.8338
SEXHEAD	.0946	.4855	.0380	1	.8454	.0000	1.0993
RICEAREA	5.4963*	2.2404	6.0185	1	.0142	.1444	243.7812
DISTMKT	.1146*	.0543	4.4517	1	.0349	.1128	1.1214
NUMOXEN	.1489	.2878	.2676	1	.6049	.0000	1.1605
SLOPE	-.5037	.3385	2.2145	1	.1367	-.0334	.6043
SHTREFIR	1.5247*	.8437	3.2662	1	.0707	.0811	4.5939
CONSTANT	4.2906*	2.1260	4.0729	1	.0436		

-2 Log Likelihood: 143.651

Goodness of Fit: 175.073

4 Conclusion

Resource endowments and household food security are affected by various factors. As most of the households with large family size do operate on a limited scale of land, most of the households are food insecure. The food insecurity is different between sexes. Wealth status in terms of oxen ownership, farm size and quality of land (slope, fertility of the soil) on one hand, and education priority given to males and females influence or determine food security differences between male and female-headed households.

Farm households in the study area use different practices of soil and water conservation measure for management of their limited land. Soil conservation measures, soil fertility and afforestation are some of the identified measures employed on private farmland. Nevertheless, it is known from the study that these practices are affected by various factors. Age, family household size, type of soil, shortage of fuel wood, availability of rice area and slope of the land affect the conservation measures practiced by the farmers. There should be clear-cut policy directions to focus on measures that would bring about sustainability and equity between the two groups of households. Food security cannot be achieved without giving much attention to micro-credit, education and training geared towards sustainable resource management.

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References

Dércon, S. and Krishman, P.; *Poverty in Rural Ethiopia 1989-1994*; Mimeo, Center for the study of African Economies, Oxford; 1994.

Maddalla, G.; *Limited Dependent Variable in Econometrics*; Cambridge University Press, UK; 1983.

Omiti, J., Patron, K. and Sinden, J.; Monitoring changes in land-use practices following agrarian de-collectivization in Ethiopia; *Agriculture, Ecosystem and Environment*; 72:111–118; 1999.

Pattanayak, S. and Mercer, D.; Valuing soil conservation benefits of agroforestry: Contour hedgerows in the Eastern Visayas, Philippines; *Agricultural Economics*; 18:31–46; 1998.

South Gondar Administrative Zone; Proposed projects for drought susceptible kebeles of Libokemekem Woreda for the year 1998-2002; Bahir Dar, Ethiopia; 1997.

Winrock International Ethiopia; PRA study conducted in Libokemekem District of Northern Gonder; Addis Ababa, Ethiopia, 74p; 2000.

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Milk Yield During the First Four Months of Lactation and Cow Productivity of Brahman and Tuli Beef Cattle in South-East Botswana

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Abstract

The climate of Botswana because of its semi-aridity, is mostly suitable for livestock farming, especially beef cattle production under extensive grazing conditions. The major indigenous cattle breed is the Tswana, while the Tuli (TT) and Brahman (BB) are popular and increasing in numbers to the cattle population of 2.5 million. In the present study, the TT (n=15) and BB (n=24) breeds were compared for cow productivity and milk production using the weigh-suckle-weigh technique. The TT cows produced more milk than BB cows (12.4 vs 9.2 kg/d) during the first four months of lactation. However, BB cows produced heavier ($P < 0.001$) calves at weaning than TT cows (164.8 vs 150.4 kg). Similarly, BB cows produced faster ($P < 0.001$) growing calves than TT cows (.69 vs .64 kg/d). Across breeds, calves born earlier in the season had a higher ($P < 0.01$) average daily gain (ADG) than those born later in the season (.69 vs .64 kg/d). It is an advantage to producers to have the majority of calves born early in the calving season (September/October) so that calves are bigger and heavier at weaning than those calves born late in the season (November/December).

Keywords: Brahman, Tuli, milk production, cow productivity, beef cattle

1 Introduction

The major agricultural activity in Botswana is beef cattle farming. The semi arid climate and erratic rainfall in Botswana favours pastoral rather than arable farming. An estimated 75% of the beef cattle herd is kept under communal grazing system and the rest in fenced commercial ranches. Traditionally, cattle have been kept for their meat and milk, draught power, social events and to some extent for prestige. Up to the present time, cattle have continued to provide the necessary nutrients in the form of milk to the rural community. Cows are usually hand milked after stimulation by the calf and the milk is consumed either fresh or as sour milk. Excess milk is usually sold to generate cash income. The Tswana is the predominant beef cattle breed. Other popular cattle breeds include the Brahman and the Tuli. There is paucity of information on the milking ability of beef cattle breeds found in Botswana including those mentioned above. The object of this study was to estimate milk production of Brahman and Tuli cows raised under commercial ranching conditions using the weigh-suckle-weigh technique during

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the first four months of lactation as well as and to compare the performance of their progeny.

2 Materials and Methods

Data were collected over a one year cycle in 1995/96 breeding season. Sixty-six cows on native pasture comprising of two groups of 33 Brahman (BB) and 33 Tuli (TT) cows were allotted of each breed for a three-month period beginning 1^{st} January to 31 March. The cow groups were allowed to run separately during the breeding season and were then mixed at the end of the season. Twenty four TT and 15 BB cows conceived and weaned a calf. Calves considered for this study were those dropped between 1^{st} September and 31^{st} December respectively.

Milk production was estimated monthly by the weigh-suckle-weight method. Calves were separated from their dams overnight beginning 6:00 p.m for 12 hours. Calves were weighed in groups, allowed to suckle for about 20 minutes and then re-weighed. The positive weight difference before and after suckling was considered as the amount of milk consumed by the calf and the estimated 12-hour milk production by the dam. Milk production data were analysed by analysis of variance using a mixed general linear method with unequal sub-class numbers. The main fixed effects were sire breed (SB), which is similar to breed of dam (DB), age of dam (DA), sex of calf (CS) , calving period (CP). Interactions were fitted in the model and dropped when found not significant ($P < 0.05$).

3 Results and Discussion

3.1 Milk production

Table 1 below shows that milk yield was influenced only by breed of sire. Tuli dams produced more ($P < 0.05$) milk than Brahman dams (12.4 vs 9.2 kg) during the first four months of lactation. This is in agreement with Reynolds *et al.* (1978) who reported that Brahman cows generally produce less milk than other beef breeds. Age of dam, sex of calf, and calving period did not ($P > 0.05$) influence milk production. Although age of dam did not significantly influence milk production, older dams tended to produce more milk than younger dams as shown on table 1. Jeffery *et al.* (1971) reported that as cows mature , they become heavier, produce more milk and raise faster gaining calves. Further work on the relationship between cow age and milk production in indigenous breeds of cattle needs to be carried out in Botswana.

3.2 Birth weight

Table 2 shows that sex of calf and age of dam significantly influenced birth weight of calves from BB and TT dams, respectively. Male calves were heavier ($P < 0.001$) at birth than female ones in the two breeds (35.6 vs 30.4 kg). This is agreement with other studies using similar breeds (Herring *et al.*, 1996; Browning Jr. *et al.*, 1995). In general, older dams (10yr and above) produced heavier calves at birth than younger dams (2 to 9 yr) as shown on table 2 below, respectively. As the cow matures, she tends

Table 1: Least squares means and standard errors (kg) for 12-hour milk production of Brahman and Tuli cows in SE-Botswana in 1995/6.

Source of Variation	*n*	*LS Means*[1]	*SE*
Breed of Sire		*	
Brahman	24	9.2^a	1.28
Tuli	15	12.4^b	0.85
Age of Dam		ns	
2 - 4 years	10	9.6^a	1.29
6 - 9 years	19	10.8^a	1.05
10 - 12 years	9	11.9^a	1.43
Sex of Calf		ns	
Male	18	11.0^a	1.12
Female	20	10.6^a	1.00
Calving Period		ns	
September/October	9	11.1^a	1.53
November/ December	30	10.4^a	0.73

[1] : Means within a column in a subgroup with different superscripts differ ($P < 0.05$)
*: $P < 0.05$; ns: not significant ($P > 0.05$)

to increase her body size including uterine capacity and birth canal which eventually will accommodate a bigger calf. Although sire breed did not significantly influence calf birth weight, BB sired calves were slightly heavier than calves sired by TT bulls (33.8 vs 32.2 kg). This is in agreement with results reported in Botswana by Trail *et al.* (1977) and by Browning Jr. *et al.* (1995) in Texas, USA.

3.3 Weaning weight

Weaning weight was adjusted for age of calf at weaning. Table 2 shows that sire breed, sex of calf and calving period significantly affected weaning weight of calves sired by BB and TT bulls. Calves sired by BB bulls were significantly heavier than those sired by TT bulls (164.8 vs 150.4 kg). Similar results were reported in Botswana by Buck et al., 1982 in crossbred Tswana cows and by Animal Production Research Unit (1981). In many other studies, generally Brahman outperforms Tuli sires in weaning weight of the calf (Herring *et al.*, 1996; Tawonezvi *et al.*, 1988; Trail *et al.*, 1977).

3.4 Growth rate

Calf growth rate was significantly influenced by breed of sire, sex of calf and calving period. Brahman calves out gained Tuli calves (.69 vs .64 kg/d). These results, are in disagreement with Browning Jr. *et al.* (1995) who reported that Tuli sired calves had a higher ADG than Brahman sired calves (.81 vs .78 kg/d).

Table 2: Least squares means and standard errors for birth weight, adjusted weaning-weight and average daily gain of Brahman and Tuli calves in South-Eastern Botswana.

	Birth Weight (kg)			*Adjusted Weaning Weight (kg)*			*Average Daily Gain (kg/d)*		
Source of Variation	*n*	*LSMean*[1]	*SE*	*n*	*LSMean*[1]	*SE*	*n*	*LSMean*[1]	*SE*
Breed of Sire		NS			***			***	
Brahman	15	33.8^a	1.25	15	164.8^a	3.12	15	0.69^a	0.013
Tuli	24	32.2^a	0.82	24	150.4^b	2.06	24	0.64^b	0.009
Sex of Calf		***			***			***	
Male	19	35.6^a	1.04	19	166.3^a	2.61	19	0.69^a	0.011
Female	20	30.4^b	1.00	20	149.2^b	2.48	20	0.63^b	0.010
Age of Dam		**			ns			ns	
2 to 4 yrs	9	30.6^a	1.21	9	154.3^a	3.03	9	0.66^a	0.013
6 to 9 yrs	20	32.2^a	1.04	20	156.0^a	2.59	20	0.66^a	0.011
10+ yrs	9	36.2^b	1.40	9	162.9^a	3.51	9	0.68^a	0.015
Calving Period		ns			**			**	
September/October	9	33.8^a	1.49	9	163.8^a	3.71	9	0.69^a	0.016
November/December	30	32.3^a	0.71	30	151.7^b	1.77	30	0.64^b	0.008

[1] : Means within a column in a subgroup with different superscripts differ ($P < 0.05$)

**: $P < 0.01$; ***: $P < 0.001$; ns: not significant

Male calves across breeds were heavier ($P < 0.001$) than female calves. Table 2 shows that calves born earlier (September/October) during the calving season were heavier ($P < 0.01$) than those born in the last part (November/December) of the season (.69 vs .64 kg/d). SWAYER *et al.* (1993) reported that time of calving had a significant effect on calf growth. This is in agreement with the present study.

4 Conclusions and Recommendations

Further research is required to compare the two beef breeds of Brahman and Tuli for a longer period of time before any concrete recommendations could be made to producers. Preliminary results so far indicate that the two breeds have different milking ability with Tuli cows having a higher milk yield than the Brahman during the first four months of lactation. However, Brahman cows weaned heavier and faster growing calves than Tuli cows. Under the traditional cattle management in Botswana, where cow milk is shared between humans and the calves, the Tuli beef cow will provide such milk according to results of the present study. Farmers should try to have cows to calve earlier in the season (September/October) so that calves are bigger and heavier at weaning.

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References

ANIMAL PRODUCTION RESEARCH UNIT; Ten years of animal production and range research in Botswana; Ministry of Agriculture, Gaborone, Botswana; 1981.

BROWNING JR., R., LEITE-BROWNING, M. L., NEUENDORFF, D. A. and RANDEL, R. D.; Preweaning growth of Angus- (*Bos taurus*), Brahman- (*Bos indicus*), and Tuli- (Sanga) sired calves and reproductive performance of their Brahman dams; *J. Anim. Sci.*; 73:2558–2563; 1995.

HERRING, A. D., SANDERS, J. O., KNUTSON, R. E. and LUNT, D. K.; Evaluation of F1 calves sired by Brahman, Boran, and Tuli bulls for birth, growth, size and carcass characteristics; *J. Anim. Sci.*; 74:955–964; 1996.

JEFFERY, H. B., BERG, R. T. and HARDIN, R. T.; Factors influencing milk yield in beef cows and affecting the preweaning performance of their calves; *Can. J. Anim. Sci.*; 51:551–560; 1971.

REYNOLDS, W. L., DE ROUEN, T. M. and BELLOWS, R. A.; Relationship of milk yield of dam to early growth rate of straightbred and crossbred calves; *J. Anim. Sci.*; 47:584–594; 1978.

SWAYER, G. J., MILLIGAN, J. and BARKER, D. J.; Time of joining affects the performance of young Angus and Angus × Friesian cattle in the south-west of Western Australia. 2. Calf productivity and its relationship with milk production and reproduction in first calvers.; *Aust. J. Exp. Agric.*; 33:523–529; 1993.

TAWONEZVI, H. P. R., WARD, H. K., TRAIL, J. C. M. and LIGHT, D.; Evaluation of beef breeds for rangeland weaner production in Zimbabwe. I. Productivity of purebred

cows; *Anim. Prod.*; 47:351–359; 1988.

Trail, J. C. M., Buck, N. G., Light, D. L., Rennie, T. W., Rutherford, A., Miller, M., Pratchett, D. and Capper, B. S.; Productivity of Africander, Tswana, Tuli and crossbred beef cattle in Botswana; *Anim. Prod.*; 24:57–62; 1977.

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The Role and Breeds, Management Systems, Productivity and Development Strategies of Goats in Indonesia: A Review

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Abstract

Small ruminants like sheep and goats are important for a larger part of the Indonesian rural population. The major breeds of goats found in Indonesia are the Kacang and Etawah goats. The biological and economic function of goats have long been recognised. Besides producing animal products, they also provide manure to maintain soil fertility. Goats are kept as an important component of farming activities, particularly by smallholders.

The existing goat husbandry is normally the result of hundreds of years of tradition. Different systems of goat production have evolved in response to factors such as climate, need of the owner, economic environment, and level of technology available. The general aim in the management of goat production units is to increase the productivity. The biological productivity of goats is determined by the fundamental processes of reproduction, growth and development and death. Key production traits which should be considered for improving goats' productivity are adaptability and productivity conditions, reproductive rate, growth rate and carcass value.

The objectives of this paper are to review the role and breeds of goats, current management systems and productivity for goats with particular reference to Indonesia, and to discuss the development strategies that may have specific applications in the Indonesian situation.

Keywords: goats, breeds, management, Indonesia

1 The Role and Breeds of Goats in Indonesia

Goats in Asia account for 62,86 percent of the total world population (FAO, 2003). Indonesia has about 13 million goats (Table 1), of which 54 percent are raised on the island of Java (Dirjen Peternakan, 2003). Table 1 shows the distribution of goats in Indonesia. Goats' population in Indonesia represents the largest population of small ruminants in South East Asian countries (Devendra and McLeroy, 1982; Utoyo, 1995), and there are many farming families involved in the production of small ruminants (Wahyuni and Suparyanto, 1991; Priyanto *et al.*, 1991; Devendra,

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1993). This suggests that goats fit well within the farming systems in the rural sector. Most importantly, goats can provide ready cash as liquid assets to meet unexpected household needs of the farmer, present insurance against crop failure, and a method of investing labour input (ATMADILAGA, 1991; DJAJANEGARA and SETIADI, 1991). The contribution of rearing goats to the total farming income is substantial, and was about 17.1, 26 and 14,8 percent for the three categories of lowland, rubber plantation and upland areas respectively (Table 2). The important implication of these figures is that goats provide a vehicle to improve the income of poor and destitute farmers (SABRANI and KNIPSCHEER, 1982; SABRANI and SIREGAR, 1981; ADJISOEDARMO, 1991).

Table 1: Distribution of goats in Indonesia from 1996 until 2000

	Number of goats (head) in year				
Provinces	*Year 1996*	*Year 1997*	*Year 1998*	*Year 1999*	*Year 2000*
DKI Jakarta	7,888	6,767	8,349	6,415	5,773
West Java	2.098,635	1,935,346	1,698,631	1,666,500	1,710,496
Central Java	2,988,780	3.053,791	2,899,335	2,812,151	2,780,649
Yogyakarta	277,241	277,583	263,265	263,397	263,402
East Java	2,549,413	2,618,502	2,232,229	2,264,992	2,345,236
Other provinces	8,016,748	9,324,349	6,458,640	5,687,918	5,960,178
Total	13,840,070	14,162,547	13,560,449	12,701,373	13,065,734

Table 2: Contribution of goats to total farm income at different locations and farm size

Location and Farm size	*Small ruminants income to total income (%)*
Cirebon (lowland)	
0 - 0.15 ha	21.6
0.15 - 0.30 ha	13.4
over 0.30 ha	13.5
Average	17.1
Garut (upland)	
0 - 0.15 ha	22.6
0.15 - 0.30 ha	22.2
over 0.30 ha	10.3
Average	13.8
Ciburay (rubber plantation)	26,0

The Kacang is an Indonesian native small goat. To improve local breeds the government imported Etawah goats from Jamnapari and north India (MERKENS and SJARIF, 1979).

The Cashmere, Angora and Saanen goats have also been introduced in the past, but only the Etawah goat has adapted to the conditions of the Indonesian farming systems (Edey, 1983; Djajanegara and Setiadi, 1991). The Marica goat is a local variation of the Kambing Kacang which is found in Sulawesi. The Gembrong goat is intermediate in size between the Kacang goat and the Etawah goat and is found exclusively on the eastern side of Bali. Costa goats are found in Banten. Angora or Montgomery goats were imported and brought to the experimental stations in Bogor, Bandung and Padang Mangatas. Holandsche-Edelgeit were even brought to Java and Sumba (Dirjen Peternakan, 1991; Utoyo, 1995; Yulistiani *et al.*, 1998; Setiadi *et al.*, 1998).

2 Management Systems

The existing husbandry management systems in tropical countries such as Indonesia are normally the results of hundreds of years of tradition. In the humid Tropics, goats are usually kept in small family flocks under semi-intensive management. On the outer island of Indonesia, they are commonly grazed or tethered and housed at night, or they are left free to scavenge around the village by day and housed at night. During the crop-growing season, these animals may be kept under the control of children or of village herdsmen.

Integration with the cropping system has been practised in varying degrees in many parts of Indonesia. The nature and extent of the integration depends upon the type of crops being grown. Increasing attention is now being given to integrating small ruminants with rubber, coconut and palm oil trees to utilise the roughage that normally grows under trees. The advantages of this system are: increasing fertility of the land because of the input of faeces and urine, control of weeds by animals, reduced costs for fertilisers as well as the increase in crop yields with greater total income.

2.1 Housing or Kandangs

Housing of animals has been traditionally part of goat production systems in the humid tropics. Besides security reasons, housing is also provided for management reasons such as the control of animals to prevent damage to crops, ease of feeding and collection of excreta.

There are several types of animal house to be found within the Indonesian archipelago. In areas where flooding occurs or where there are predators, farmers build animal houses quite high above the ground. These types of houses are found on the islands of Sumatra and Kalimantan. In other areas, farmers may keep their goats under or inside their houses. The farmer's house may be built one to two metres above ground level with the animals directly underneath or the animal barn may be adjacent to the kitchen, utilising one of its walls. This is, however, contrary to the Department of Health regulations. Animal houses may also be on ground level.

The stilted housing type is more commonly used, since in the humid tropics rainfall is heavy and temperatures are high. This type of housing protects the animals from the wet and facilitates easy cleaning and collecting of the faeces and urine for fertiliser. The floor usually consists of slats of bamboo or wood, which allow faeces and urine to

fall through and provides greater air movement around the animal. The resulting air movement in stilted houses also reduces the effects of high temperatures on animals.
Most animal houses in Indonesia have open sides for better ventilation to remove both sensitive heat and humidity (from the animals and its excreta). The roof provides shade from direct sunlight and from rain. The roof should provide effective shelter from heavy rain and high solar radiation. The roof materials can be made of coconut or palm leaves grass or alang-alang (*Imperata cylindrica*), tiles or zinc.
SODIQ *et al.* (1998b) found that nearly 80 percent of smallholders keep goats and sheep together in one pen. This has distinct disadvantages. Firstly, different categories of animals need different qualities and quantities of feed. For example, weaners as well as females in late pregnancy and during lactation need better feed. Of course it is not possible to feed different classes of stock differently, if there is only one pen. Male goats may disturb others. For example, young females may be mated too early, or unsuitable mating may occur. Parturient females should be separated from the rest of the flock, so that they can quickly establish the exclusive maternal-offspring bond.

2.2 Mating

Farmers prefer keeping female to male animals since each female can rear new offspring whereas one male can mate with a large number of females. Because of this, farmers rarely keep adult male animals. If there is an adult male, it is often kept in a separate pen.
Although well-fed kids can be mated at around seven months (CHANIAGO, 1994), probably under most village conditions where growth rates are slow, they should not be mated under 12 months of age. In fact many are not mated until 18 months to two years of age.

2.3 Feeding System

The range of feeding systems in Indonesian animal husbandry encountered in villages, varies depending upon which crops are planted, area, tradition and many other factors. The feeding systems include hand-feeding or cut-and-carry systems, herding, tethering, free-range grazing and combinations of these systems.

2.3.1 Hand-feeding (cut-and-carry) Systems

Animals are usually kept inside all the time except may be for mating, bathing or for treatment. This system of management is generally found in villages with high population densities and intensive cultivation systems. Animals raised under this system generally perform better and are in better body condition than tethered or scavenging animals. This is because with this system it is usually possible to provide the livestock with better quantity and quality of feed and they do not have to spend time and energy walking around looking for feed. However, the quantity and quality of feed offered depends entirely upon the farmers´ capability and knowledge of good quality foodstuffs. Also, during times when the farmer is busy with food crops, the quality and quantity of feed harvested probably declines. The farmer using this system can more easily watch

the health of animals.
Animals in pens are fed once, twice or three times daily. Fodder is cut from the harvested paddies, arable land, and bank of rivers or sides of irrigation canals, from roadsides or from certain other areas and carried by farmers to the animals' pens. Hand feeding is practised where grazing areas are limited, but fodder is available for cutting. In Indonesia, it is recommended to cut leaves of ipil-ipil (*Leucaena leucephala*), jack fruit (*Artocarpus integrifera*), cassava (*Manihot esculenta*), sesbania, glyricidia and calliandra to feed goats.

2.3.2 Herded Systems

In Indonesia, this management system is more generally used with sheep than with goats because sheep have a stronger flocking instinct. The number of animals in a flock varies widely depending on the area, but usually it is limited to 10 to 40 animals. This system can be seen in paddy field areas during the dry season when the fields have not yet been planted, because there is no irrigation water available. When the rainy season comes, farmers start to cultivate the paddy fields and their livestock can only be grazed on roads.
The animals are grazed under the control of children or herdsman, mainly on communal grazing areas or non-productive land such as fallow rice or other crop land, road sides, river banks or sides of irrigation canals. Herding may be practised all year round or for only part of the year.

2.3.3 Tethered Grazing

The animal is tethered by a rope attached to a pole or peg which enables a small circular area to be grazed with a minimum of labour. It is common on scattered crop lands, on road sides in Sumatra and Kalimantan.
With this system, the access of animals to grasses or leaves can be very limited in term of quality and quantity, so it is necessary to move the animals as frequently as possible, at least once and preferably several times a day. However, pressure of work often prevents the farmers from moving their animals sufficiently often to ensure good nutrition. With this system of raising livestock, the farmers are able to use their time more efficiently for other work. While their livestock are tethered, the farmers can carry out work including their most important work on paddy fields.

2.4 Disease Control

One of the factors affecting livestock production in Indonesia is animal health, rendering programmes for control of livestock disease very important as such diseases can cause large economics losses (Dirjen Peternakan, 2003). There is little information available about the relative and economic importance of different diseases in Indonesia although a number of reviews have been written. It has been reported that parasitic disease is by far the most prominent (Ginting *et al.*, 1994).
Small ruminant farmers in Indonesia often treat their sick animals with natural herbs that grow in the surrounding areas. This knowledge is generally obtained from the elders

in the village and neighbours who have had previous experience. There are a number of remedies that are often used by farmers to treat diseases in animals. For instance, a mixture of sulphur and used engine oil is considered a cure against scabies, ground areca palm (pinang) fruit is given to adults goats to reduce the burden of intestinal parasites. Recently, a survey showed that a number of traditional medicines are generally used by farmers in East Java (KOMARUDIN, 1990). There is a need for more information to justify traditional treatment in order to provide farmers with inexpensive methods to treat their sick goats. This might reduce the high mortality rate encountered in goats in the villages and also limit the need to import expensive pharmaceutical drugs which smallholders cannot afford to buy.

2.5 Recording

Records are necessary for efficient management but must be kept simple because goats are only the sideline of farming enterprises and smallholders have neither sufficient time nor skill to maintain a complex recording system. Some system of marking has to be adopted and there are many different kinds, which are not necessarily expensive.
Breeding records that should be kept are: date of mating, date of birth, number offspring born (dead and alive) and if possible birth weight, survival to and weight at weaning. At present, few farmers keep records but they should be encouraged to do so. This has become feasible with almost complete literacy in young farmers.
Records can be kept for many purposes (PEACOCK, 1996). SODIQ *et al.* (1997) designed the model of breeding records, especially for students in practical work in rural areas, and the model has also been designed by the Division of Livestock Service (1996) used at the "Animal Breeding Centre".

3 Productivity of Goats in Indonesia

The keys traits and the production factors that affect efficient meat goat production (MCGOWAN and NURSE, 2000; DEVENDRA and MCLEROY, 1982; GATENBY, 1995): (1) Adaptability; (2) Reproduction performance; (3) Growth rate and productivity, and (4) Carcass characteristic.

3.1 Adaptability

As a humid tropical country, Indonesia has special problems associated with animal production. Animal production is the result of the interactions of genotypes and environmental factors such as climate, nutrition, disease and management practices. The effect of an environmental change on the production processes is a consequence of the neuro-endocrine and behavioural responses to the change. Table 3 shows the growth rate of Peranakan Etawah goats in different environments at different altitudes (WINUGROHO *et al.*, 1994). Table 4 shows the litter size and reproduction rate of Peranakan Etawah goats in different agro-climate (medium dry period with rainfall 2,000-3,000 mm; and short dry period with rainfall more than 3,000 mm) (YUSRAN *et al.*, 1991).

Table 3: Growth rate of goats in different environments

Altitude (m above sea level)	*Air temperature* (° C)	*Growth rate* (g/day)
700	6.6 - 31	94
300	20 - 33.5	70

Table 4: Litter size and reproduction rate with different rainfall

Characteristics	*Location*	
	Medium dry period	*Short dry period*
Litter size (kid)	1.74	1.48
Reproduction rate (kid/2 year)	4.7	3.3

3.2 Reproduction Performance

The reproductive rate of both individual goats and the flock as a whole is an important determinant of the overall success of the flock (PEACOCK, 1996). Some measurements used to assess individual reproductive performance: parturition interval, litter size, preweaning mortality rate, postweaning mortality rate. Some researchers have investigated the reproduction performance of goats in Indonesia, their results presented in Table 5 and 6 for Kacang and Peranakan Etawah goats, respectively.

SUTAMA (1994) investigated the puberty and early reproductive performance of Peranakan Etawah goats (Table 7). It was concluded that Peranakan Etawah goats reached puberty at about 56 percent of mature liveweight. Abortion and high proportion returned to oestrous of goats at their first breeding period are potential sources of reproductive inefficiency of young Peranakan Etawah goats. SANDHI (1992) reported that the type of birth for single, twin and triplet with Peranakan Etawah goats were 37,18; 53,85; and 8,97 percent, respectively. Kidding interval at single, twin and triplet birth type were 393, 347 and 315 days, respectively.

SODIQ *et al.* (2003) investigated some factors affecting the reproduction characteristics of Kacang and Peranakan Etawah goats under smallholders. Their results show that the type of birth was significantly affected by parity. Survival rate, kidding interval, doe reproduction and productivity were significantly affected by parity, type of birth and litter weight at weaning. Table 8 and 9 show the average doe reproduction of Kacang and Peranakan Etawah goats at different parity and types of birth respectively.

Table 5: Litter size, survival rate till weaning and kidding interval of Kacang goats

Location	*Litter size (head)*	*Survival rate till weaning (%)*	*Kidding interval (year)*	*Researchers*
Bogor (Experim. Station)	1.76	-	0.57	BPPP (1995)
Purworejo (Villages)	1.40	95.3	-	Astuti *et al.* (1984)
Temanggung (Villages)	1.73	92.3	-	
Bogor (Experim. Farm)	1.56	-	-	Subandriyo *et al.* (1986)
Villages	-	-	0.59	Ditjennak (1979)
Semarang (Villages)	1.92	-	0.64	Sumarti (91)
Cilacap (Villages)	1.98	95	0.79	Amsar *et al.* (1992)
Banyumas (Villages)	1.95	97	0.71	Sodiq *et al.* (1997)

Table 6: Litter size, survival rate till weaning and kidding interval of Peranakan Etawah goats

Location	*Litter size (head)*	*Survival rate till weaning (%)*	*Kidding interval (year)*	*Researchers*
Bogor (Villages)	1.7	88.4	0.95	Bell *et al.* (1982)
Cirebon (Villages)	1.5	83.4	1.25	
Kendal (Villages)	1.3	100	-	Astuti *et al.* (1984)
Purworejo (Villages)	1.5	95.3	-	
Temanggung (Villages)	1.7	94.1	-	
Bogor (Experimental Farm)	1.42	66.1	-	Subandriyo *et al.* (1986)
Cirebon (Villages)	1.37	67.2	-	
Villages	-	-	0.63	Ditjennak (1979)
Villages	-	-	0.82	Abdulgani (1980)
Villages	-	-	0.99	Triwulaningsih (1989)
Bandung (Villages)	1.82	92.8	0.97	Sandhi (1992)
Bogor (Villages)	1.45	88.3	0.72	Anggraeni *et al.* (1995)
Banyumas (Villages)	1.65	93	0.96	Sodiq *et al.* (1998b)
Purworejo (Villages)	1.77	-	0.9	Setiadi *et al.* (1999)
Bogor (Experimental farm)	1.65	-	-	Adiati *et al.* (1998)

Table 7: Reproductive performance of Peranakan Etawah goat at around puberty and first kidding

Characteristics	*Means ± S.E.*
Pubertal:	
Number of goats	60
Initial liveweight (kg)	16.2 ± 0.2
Pre-pubertal growth (g/d)	37.1 ± 1.8
Puberty:	
Liveweight	18.5 ± 0.4
Ovulation rate	0.9 ± 0.1
First Kidding:	
Liveweight of does (kg)	24.3 ± 0.7
Litter size	1.0 ± 0.0

Table 8: Average doe reproduction of Kacang and Peranakan Etawah goats at different parity

Parity	*Doe reproduction (head/doe/year)*	
	Kacang goat	*Peranakan Etawah goat*
1^{st} parity	1.9	1.28
2^{nd} parity	2.28	1.63
3^{rd} parity	2.95	1.94
4^{th} parity	3.84	2.47
5^{th} parity	3.32	2.12
6^{th} parity	2.66	-

Table 9: Average doe reproduction of Kacang and Peranakan Etawah goats with different type of birth

Type of birth	*Doe reproduction (head/doe/year)*	
	Kacang goat	*Peranakan Etawah goat*
Single	1.41	1.10
Twin	2.98	2.16
Triplet	4.58	3.51

3.3 Growth Rate till Weaning and Doe Productivity

Growth rate can be effectively divided into two periods: pre-weaning average daily gain and post-weaning average daily gain (EDEY, 1983). A high pre-weaning average daily gain not only reflects the genetic potential of the growing animals, but also the mothering ability of the doe (LUGINBUHL, 2000). Body weight at birth and at weight at weaning, and growth rate of goats in Indonesia have been investigated by some researchers, their results are summarized in Table 10 and 11 for Kacang and Peranakan Etawah goats respectively.

Table 10: Average body weight at birth and at weaning, and growth rate of Kacang goats at different locations

Location (condition)	*Average body weight (kg)*		*Average daily gain (g)*	*Researchers*
	At birth	*At weaning*		
Villages	2.4	-	53.2	ASTUTI *et al.* (1984)
Breeding centre	2.0	9.0	-	SETIADI and SITORUS (1984)
Village	1.7	9.7	-	NGADIYONO *et al.* (1984)
Breeding centre	-	6.9	-	SETIADI and SITORUS (1984)
Breeding centre	-	-	20.5	TRIWULANINGSIH (1989)
Experim. Farm	-	-	63.2	SITORUS *et al.* (1995)

Table 11: Average body weight at birth and at weaning, and growth rate of Peranakan Etawah goats at different locations

Location (condition)	*Average body weight (kg)*		*Average daily gain (g)*	*Researchers*
	At birth	*At weaning*		
Villages	2.5	-	65.4	ASTUTI *et al.* (1984)
Breeding centre	2.6	10.7	-	SETIADI and SITORUS (1984)
Village	-	-	-	NGADIYONO *et al.* (1984)
Breeding centre	-	8.6	-	SETIADI *et al.* (1987)
Villages	2.5	9.9	-	Setiadi (1989)
Breeding centre	2.9	8.9	-	TRIWULANINGSIH (1989)
Breeding centre	3.3	12.7	62.4	Sutama *et al.* (1995)
Experim. Farm	3.8	-	-	ADIATI *et al.* (1998)

Growth rate until weaning and doe productivity of Kacang and Peranakan Etawah goats were significantly affected by parity and type of birth (SODIQ *et al.*, 2003). Average growth rate until weaning and doe productivity of Kacang and Peranakan Etawah goats at different parity and type of birth are presented in Table 12 and 13, respectively.

Table 12: Average doe productivity of Kacang and Peranakan Etawah goats at different parity

Parity	*Doe productivity (kg/doe/year)*	
	Kacang goat	*Peranakan Etawah goat*
1^{st} parity	17.72	22.56
2^{nd} parity	22.00	29.68
3^{rd} parity	29.12	35.73
4^{th} parity	40.03	44.84
5^{th} parity	34.15	36.16
6^{th} parity	23.24	-

Table 13: Average doe productivity of Kacang and Peranakan Etawah goats at different litter size

Litter size	*Doe productivity (kg/doe/year)*	
	Kacang goat	*Peranakan Etawah goat*
Single	14.82	21.21
Twin	29.72	38.75
Triplet	45.01	57.35

3.4 Carcass Characteristics

Carcass characteristics of interest are carcass weight, dressing percentage, ratios of lean : fat : bone, and anatomical distribution of muscle. Generally, the dressing percentage of goats is around 40-50%. As an animal grows, it tends to increase the percentage of fat in the carcass, decrease the percentage of bone while the percentage of lean stays about the same (Boggs and Merkel, 1993; Luginbuhl, 2000). Umiyasih *et al.* (1993) and Rismaniah *et al.* (1989) reported that dressing percentage of Kacang and Peranakan Etawah goats ranged from 45.4 - 48.6%, and depends on the age of animals. The average slaughter weight and carcass weight of Kacang and Peranakan Etawah goats are presented in Table 14 and 15, respectively. Sodiq *et al.* (1998b) reported that there were relations between body weight and carcass weight. The carcass weight of local goats in Banyumas' slaughterhouses ranged from 43 up to 48%.
Sudarmoyo (1983) studied the growth rate of tissues of Kacang goats based on an allometry equation (Huxley Allometrix) and revealed that there was no significant effect of sex on the growth of carcass tissues. Table 16 shows the relative growth of carcass tissue of Kacang goats.

Table 14: Average slaughter weight and dressing percentage of Kacang goats at different sex and age

Sex and Age	*Slaughter weight (kg)*	*Dressing percentage (%)*
Male		
1-1,5 years	14.2	45.4
1,5-2 years	17.0	45.6
2-3 years	19.5	46.0
Female		
1-1,5 years	14.4	45.9
1.5-2 years	17.1	46.5
2-3 years	20.0	47.4

Table 15: Average slaughter weight and dressing percentage of female Peranakan Etawah goats at different age

Age	*Slaughter weight (kg)*	*Dressing percentage (%)*
1-1,5 years	21.3	48.2
1,5-2 years	24.6	48.6
2-3 years	28.0	45.6

4 Development Strategies

The strategy is a unified system with the smallholders farming system as the central unit of the industry. The mechanism of the strategy should reflect the importance of the smallholders system as a basis of the production system (Djajanegara and Setiadi, 1991; Adjisoedarmo, 1991). There are a number of important development strategies that are worthy of attention. This includes considering the genetic improvement (Edey, 1983; Bradford, 1993; Peacock, 1996; Tawfik, 2001), clear production objectives, developing the avenues of production that are consistent with sustainability, continuing research and validation of research results (Devendra and McLeroy, 1982; Devendra, 1993; Adjisoedarmo, 1991; Koemono, 1991; Soedjana, 1993).

(a) Genetic improvement. Three methods can be used for improving genetic potential for production: (1) import breeds selected for these traits, to replace the local breeds; (2) import improved breeds, crossed with the local breeds and use F_1 or later generations from the cross as the production stock; (3) select within a local breed or crossbred population based on local breeds.

(b) Clear production objectives. It is important to decide on clear objectives of goat keeping (for meat ,milk or dual purposes). To improve quantity of the meat goat include: total meat yield per animal, total amount of lean meat in the carcass, growth rate, total number of animals available for slaughter. To improve quantity of the milk goat include: total yield, lactation length and number of lactations.

Table 16: Relative growth of carcass tissue (Y) fixed on carcass weight (X) based on $\log Y = \log a + b$

Y and Sex		a	b	r^2
Bone				
	Male	0.57	0.64	0.75
	Female	0.05	0.79	0.85
Muscle				
	Male	-1.01	1.24	0.93
	Female	-0.49	1.08	0.97
Fat				
	Male	-1.47	0.99	0.14
	Female	-2.54	1.34	0.25

(c) Developing the avenues of production. The prevailing avenues of production need to be examined critically and exhaustively. Priority should be given to the development of the production system that integrate goats with mixed cropping, especially in smallholders' farm systems. It is essential in this task to use appropriate breed(s) and choose these in relation to production objectives, suitability for a given agro-ecological environment and the development of sustainable agriculture.

(d) Continuing research. Continuing research is vital to sustain and stimulate increased production from goats. There should be a clear focus on breed characteristics, genetic potential, feed resources, feeding and nutrients, physiology, breeding and genetics, improvement management practices, prevention and control of disease, carcass quality and processing. Research priorities are essential in which there should be a balance between fundamental and applied research. Research needs to be identified with the real problems at the farm level and to include the poor and landless peasants who own goats.

(e) On-farm validation of results. Most research activities within national programmes tend to be carried out on experimental stations and are usually intensive in approach, without wider appreciation of farming systems. This tendency needs to be corrected.

The following points could be taken into account concerning the improvement of management systems for smallholders in rural areas (Chaniago, 1994; Adjisoedarmo, 1991; Anggraeni *et al.*, 1995; Sodiq, 2000, 2001; Sodiq *et al.*, 1998b):

(a) Among improvements in management which are feasible, are subdivision of animal sheds to enable better management of the different classes of stock. Better management during mating and during the perinatal period are two areas where improvements could be carried out without extra costs to the farmer. A major problem is the unavailability of bucks at oestrous as well as inability of the farmer to detect the oestrus doe either due to ignorance or to lack of time. Sharing of

males by a group of farmers is one solution, and less expensive than provision of one male per flock. Extension efforts are needed to improve the farmers' skill in oestrous detection.

(b) Improvement of management during the perinatal period is another area which would not need extra cash input. This necessitates the subdivision of animal sheds to allow isolation of the dam and her offspring necessary for the establishment of a strong maternal-offspring bond. It means intervention by the farmer to help weak neonates to obtain that first crucial drink of colostrum which is necessary for survival. This intervention needs to be skilfully applied and may well require training of the farmer or the farmers' family by extension staff. It does not require great strength, but time, so it could be taught to the wife and older children in the family.

(c) Pharmaceutical remedies for the various health problems are well known and effective. Unfortunately, however, they are also expensive, and outside the reach of the smallholder farmer. Farmers already know and use many traditional remedies which are extracted from local plants. There is urgent need for the evaluation of traditional medicines, which are affordable by the smallholder farmer.

(d) Training and provision of extension personnel knowledgeable in farming systems' approach to whole farm management, with up-to-date knowledge of research findings in the different areas and ability to communicate with smallholder farmers, remains a high priority.

There are two main approaches in goat improvement strategies (Peacock, 1996): (1) The improvement of existing systems of goat production. The approach to improving existing systems of goat production should be one of a stepwise progress, in keeping with the owner's objectives. After identifying the owner's reasons for keeping goats and defining with the owner what would be an improvement, technical or economic improvements can be designed. (2) Stocking-restocking people who do not own goats. Supplying goats to people who do not currently own them is a very attractive way for a donor-assisted project to make an immediate and significant impact. There are two main approaches. Firstly, extending goat ownership within a community, often to the poorest members, by providing finance, normally in the form of credit for purchase of goats, either local or improved. Secondly, restocking farmers who have lost their goats, and thus their livelihood, during a drought, disease epidemic or warfare.

Concerning these strategies (Adjisoedarmo, 1991) reported that an effort to improve on the number of owners and the production performance of existing goats has been undertaken from 1980 to 1990 under the Provincial Development Programme (PDP) supported by the Small Ruminant Credit Project. The target group were the rural poor with 145 villages covered. Based on that project it can be concluded that the small ruminant loan-in-kind project could be used as a means (1) of introducing an improved and appropriate technology, especially artificial insemination for goats, (2) increasing the farmer's income, (3) improving the production performance in rural areas, and (4) improving the farmer's group dynamics.

Sabrani and Knipscheer (1982) reported that the Indonesian government encountered the problem of stagnant livestock numbers with a number of so-called animal "dropping" schemes. These are animal distribution programmes where animals are provided on credit according to the traditional gadohan. Under this system female animals are distributed and part of their offspring are used as pay back. Such a sharing agreement is common in all villages of Java as in other parts of Indonesia. Animals are lent by owners to neighbours, relatives or friends in return for a share of the offspring. The gadohan system offers an excellent opportunity for animal distribution, especially if the credit and repay condition are carefully spelled out. Sodiq *et al.* (1997, 1998a); Setyaningrum *et al.* (1999) use the "gadohan system" in the project of implementation technology for increasing the income of goat smallholders in rural areas. Presently there are a growing number of goats' distribution schemes based on the sharing principles in Java.

5 Zusammenfassung

Die kleinen Wiederkäuer, Schafe und Ziegen, sind für den ländlichen Raum in Indonesien von großer Bedeutung. Die verbreiteten Ziegenrassen in Indonesien sind die „Kacang"- und die „Etawah"-Ziegen. Die ökonomische und biologische Bedeutung der Ziegen sind wohl bekannt. Neben den tierischen Produkten ist der Koteinsatz als Düngemittel von Bedeutung. Ziegen sind ein wichtiger Bestandteil der bäuerlichen Betriebe und sind das Ergebnis langer Tradition.

Verschiedene Haltungssysteme für Ziegen haben sich auf Grund des Klimas, der Betriebsbedürftigkeit und der wirtschaftlichen Lage entwickelt. Das Ziel der Ziegenhaltung ist die Verbesserung der Produktivität, die ausschlaggebend von der Reproduktion, Wachstum und Mortalität abhängig ist.

Das Ziel der vorliegenden Arbeit ist, die Arbeiten über die Rolle des Zuchtmaterials, des Management und der Produktivität sowie Maßnahmen zur Verbesserung der Ziegenhaltung in Indonesien, zusammenzustellen.

References

Adiati, U., Yulistiani, D., Sianturi, R. S. G., Hastono and Budiarsana, I. G. M.; Pengaruh Perbaikan Pakan terhadap Respon Reproduksi Induk Kambing Peranakan Etawah [Effect of the Feeding Improvement on Reproduction Performance of Peranakan Etawah]; Prosiding Seminar Nasional Peternakan dan Veteriner; Bogor, December 1-2 1998; 1998; [Indonesian].

Adjisoedarmo, S.; Small Ruminant Loan-on Kind Project in Central Java; in: *Proceeding of the International Seminar, October 1991*; Brawijaya University, Malang, Indonesia; 1991.

Amsar, Soedjadi, Priyono, A. and Setyanigrum, A.; Pertumbuhan dan Daya Hidup Cempe Prasapih di Kabupaten Cilacap [Growth and Preweaning Survivability of Goats in Cilacap District]; Laporan Penelitian; Universitas Jenderal Soedirman. Purwokerto; 1992; 42 pp. [Indonesian].

Anggraeni, D., Sianturi, R. S. G., Handiwirawan, E. and Setiadi, B.; Dampak Perbaikan Manajemen terhadap Produktivitas Domba dan Kambing [The effect of

improving management on doe and ewe productivity]; in: *Proceedings Sciences and Technology National Meeting*; pages 374–379; Bogor, Indonesia; 1995; [Indonesian].

ASTUTI, M., BELL, M., SITORUS, P. and BRADFORD, G. E.; Pengaruh Ketinggian Tempat Terhadap Produksi Domba dan Kambing [The Impact of Altitude on Sheep and Goat Production]; Working Paper; Balai penelitian Ternak, Bogor; 1984; [Indonesian].

ATMADILAGA, D.; Relation of Livestock Development to Farmers Income in the Tropics; in: *Proceeding of the International Seminar, October 1991*; Brawijaya University, Malang, Indonesia; 1991.

BELL, M., INOUNU, I. and SUBANDRIYO; Variability in Reproductive Performance on Sheep and Goats among Villages Farms in West Java; in: *Proceedings 5^{th} World Conference on Animal Production; August 1982*; Japan; 1982.

BOGGS, D. L. and MERKEL, R. A.; *Live Animal Carcass Evaluation and Selection Manual*; Kendall- Hunt Publishing, Dubuque, Iowa; 1993; 234pp.

BPPP; Laporan Tahun 1995 [Report on Year 1995]; Balai Pusat Penyelidikan Peternakan, Bogor; 1995; [Indonesian].

BRADFORD, G. E.; Small Ruminant Breeding Strategies for Indonesia; in: *Proceedings of a Workshop Held at the Research Institute for Animal Production, August 3-4 1993*; pages 83–94; Bogor; 1993.

CHANIAGO, T. D.; *Tatalaksana Pemeliharaan Ternak Ruminansia Kecil Dewasa ini [Present Management System of Small Ruminants]*; UNS-Press; 1994; pp.34-50; [Indonesian].

DEVENDRA, C.; *Goat and Sheep in Asia: in Small Ruminant Production in the Humid Tropics*; Sebelas Maret University Press, Surakarta, Indonesia; 1993; 467pp.

DEVENDRA, C. and MCLEROY; *Goat and Sheep Production in the Tropics*; Intermediate Tropical Agriculture Series; Longman Group Limited, Essex, UK; 1982; 271pp.

DIRJEN PETERNAKAN; Pedoman Standar Bibit Ternak di Indonesia [Standard of Livestock Breeds in Indonesia]; Dirjen Peternakan, Jakarta; 1991; [Indonesian].

DIRJEN PETERNAKAN; *Buku Statistik Peternakan [Statistical Book on Livestock]*; Dirjen Peternakan, Jakarta; 2003; [Indonesian].

DITJENNAK; Laporan Hasil Survey Inventarisasi Sumber Bibit Kambing dan Domba di Indonesia [Report of the Goat and Sheep Sources in Indonesia]; Dirjen Peternakan, Jakarta; 1979; [Indonesian].

DJAJANEGARA, A. and SETIADI, B.; Goat production in Indonesia; in: *Goat Reproduction in the Asian Humid Tropics. Proceedings of an International Seminar, Held in Thailand, 28-31 May 1991*, edited by RESTALL, B. J.; pages 1–6; 1991.

EDEY, T. N.; The genetic Pool of Sheep and Goats; in: *Tropical Sheep and Goat Production*, edited by N., E. T.; pages 3–5; AUIDP, Canberra; 1983.

FAO; FAOSTAT Database; http://aps.fao.org/; 2003.

GATENBY, R. M.; *The Tropical Agricultural Series: Sheep*; ICTA, Macmillan Education Ltd., London; 1995; 153pp.

GINTING, N., ACHJADI, R. K., DAMANIK, R. and SUDARSONO; Aspek-aspek Kesehatan pada Produksi Kambing dan Domba [Health Aspects of Goat and Sheep Production]; UNS-Press; 1994; pp.336-368; [Indonesian].

KOEMONO, R.; Usaha Peningkatan Produktivitas Peternakan di Jawa Tengah dalam Pembangunan yang Berkelanjutan. [An Effort to Increase the Animal Productivity in Central Java in Relation to Sustainable Development]; in: *Proceeding Seminar Nasional on Improving the Productivity of Animal Industry and Fisheries; October 1991*; University of Diponegoro, Semarang; 1991; [pp.336-368, Indonesian].

KOMARUDIN, M.; Bahan Obat dan Pengobatan Tradisional untuk Ternak di Jawa Timur [Traditional Medicine for Livestock in East-Java]; Sub-Balai Ternak Grati, Pasuruan, Indonesia; 1990; 75pp. [Indonesian].

LUGINBUHL, J. M.; Breeds of Goats for Meat Goat Production and Production Traits; Department of Animal Science, NCSU; http://www.cals.ncsu.edu; 2000.

MCGOWAN, C. and NURSE, G.; Production Factors Affecting Meat Goat Production; Department of Animal Science, University of Florida. http://www.famu.org; 2000.

MERKENS, J. and SJARIF, A.; Sumbangan Pengetahuan tentang Peternakan Kambing di Indonesia [The Contributions of Knowledge on Goat Husbandry in Indonesia]; LIPI, Jakarta; 1979; pp25. [Indonesian].

NGADIYONO, N., BASUKI, P. and MURDJITO, G.; Beberapa Data Performan Ternak Kambing yang Dipelihara secara Tradisional di Pedesaan Hingga Umur Satu Tahun [Data of the Goat Performance under Traditional Management System]; Prosiding Pertemuan Ilmiah Ruminansia; Bogor, 8-10 November; 1984; [Indonesian].

PEACOCK, C.; *Improving Goat Production in the Tropics, A Manual for Development Workers*; Oxfam, U.K and Ireland; 1996; 386pp.

PRIYANTO, D., WAHYUNI, S. and TIESMURTI, B.; Women's Knowledge of Small Ruminant Breeding and Reproduction; in: *Proceeding of the International Seminar, October 1991*; Brawijaya University, Malang, Indonesia; 1991.

RISMANIAH, I., AMSAR, SOEDJADI and PRIYONO, A.; Studi Karkas Kambing Lokal [Study of the Local Goat Carcasses]; Prosiding Pertemuan Ilmiah Ruminansia; Bogor, 8-10 November; 1989; [Indonesian].

SABRANI, M. and KNIPSCHEER, H. C.; Small Ruminant for Small Farmers; *Journal of Indonesian Agricultural Research and Development*; 4(3):86–90; 1982.

SABRANI, M. and SIREGAR, A. P.; The Role of Small Ruminants in Traditional Indonesian Farming Systems; *Journal of Indonesian Agricultural Research and Development*; 3(4):99–104; 1981.

SANDHI, G. N.; Interval Beranak pada Kambing Peranakan Etawah yang Dipelihara secara Tradisional [Kidding Interval of Peranakan Etawah Goats under Traditional Management System]; Proceedings Seminar Nasional Teknologi Bioreproduksi dalam Mendukung Peternakan yang Tangguh. Jenderal Soedirman University, Purwokerto, February 8; 1992; [Indonesian].

SETIADI, B., MATHIUS, I. W. and SUTAMA, I. K.; Karakteristik Sumberdaya Kambing Gembrong dan Alternatif Pola Konservasinya [Characteristics and Conservation of Gembrong Goats]; Seminar Nasional Peternakan dan Veteriner, Bogor, October; 1998; [Indonesian].

SETIADI, B., PRIYANTO, D. and SUBANDRIYO; Karakteristik Morfologik dan Produktivitas Induk kambing Peranakan Etawah di Daerah Sumber Bibit Kabupaten Purworejo [Morphologic Characteristics and Productivity of Peranakan Etawah Goats in

Purworejo]; Prosiding Seminar Nasional Kiat Usaha Peternakan; Jenderal Soedirman University, Purwokerto, August; 1999; [Indonesian].

Setiadi, B. and Sitorus, P.; Penampilan Produksi dan Reproduksi Kambing Peranakan Etawah [Reproduction and Productivity Performance of Peranakan Etawah Goat]; Prosiding Pertemuan Ilmiah Ruminansia; Bogor, 8-10 November; 1984; [Indonesian].

Setiadi, B., Sitorus, P. and Subandriyo; Produktivitas Ternak Kambing pada Stasiun Percobaan Cilebut Bogor [Goat Productivity on Station Farm Cilebut Bogor]; Ilmu dan Peternkan 3:5; 1987; [Indonesian].

Setyaningrum, A., Warsiti, T. and Socheh, M.; Aplikasi kalender Reprodukai dan Pejantan Peranakan Etawah untuk Meningkatkan Produktivitas Kambing di Purworejo [Application of the Reproduction Calendar and Buck of Peranakan Etawah for Improving Goat Productivity in Purworejo]; Extension Report. Universitas Jenderal Soedirman. Purwokerto; 1999; 50 pp. [Indonesian].

Sitorus, S., Martawidjaja, M. and Setiadi, B.; Pertumbuhan Anak Kambing Kacang Lepas Sapih yang Berbeda Tipe Kelahiran dan Jenis Kelamin [Post-weaning Growth of Kacang Goats at Different Birth Type and Sex]; Prosiding Seminar Nasional Sains dan Teknologi Peternakan; Bogor, 25-26 January 1995; 1995; [Indonesian].

Sodiq, A.; Ewe and Doe Productivity under Village and Improved Management System; in: *Proceedings International Symposium Cum Workshop: Sustainable Development*; pages 119–124; Bogor, Indonesia; 2000.

Sodiq, A.; Produktivitas Induk Kambing pada Pemeliharaan Sistem Berkelompok dan Individual di Pedesaan [Doe Reproduction under Organized and Individual Management System in Rural Areas]; *Journal of Rural Development, Univ. of Jenderal Soedirman*; 1(3):47–58; 2001.

Sodiq, A., Adjisoedarmo, S. and Tawfik, E. S.; Productivity of Kacang and Peranakan Etawah Goats and Factors Affecting Them in Indonesia; 2003; unpublished; Research Report.

Sodiq, A., Priyono, A. and Sumaryadi, M. Y.; Parameter-parameter Demografik Peternakan Kambing dan Domba di Kabupaten Banyumas [Demographic Parameters for Goats and Sheep in Banyumas Regency]; Research Report. Dept. of Animal Production, Univ. of Jenderal Soedirman. Purwokerto; 1998a; 42 pp. [Indonesian].

Sodiq, A., Setyaningrum, A., Haryanto, B., Warsiti, T., Socheh, M., Priyono, A. and Soedjadi; *Petunjuk Praktekum Peternakan Rakyat [Handbook for Practical Work in Smallholders and Rural Areas]*; Department of Animal Production, Jenderal Soedirman University,, Purwokerto; 1997; 20pp. [Indonesian].

Sodiq, A., Setyaningrum, A. and Haryoko, I.; Studi tentang Komparasi Karkas Domba dan Kambing di Banyumas. [Study on Comparison of the Sheep and Goats Carcasses in Banyumas]; *Scientific Publication, Univ. of Jenderal Soedirman*; 18(1):41–51; 1998b; [Indonesian].

Soedjana, T. J.; *Aspek Ekonomi Beternak Ruminansia Kecil [Economics of Raising Small Ruminants]*; UNS-Press; 1993; pp.336-368, [Indonesian].

Subandriyo, Setiadi, B. and Sitorus, P.; Produksi Kambing Etawah di Stasiun Percobaan Bogor dan Cirebon Jawa Barat [Performance of Etawah Goats at Station

in Bogor and Cirebon West-Java]; Working Paper; Balai Penelitian Ternak; Bogor; 1986; [Indonesian].

SUDARMOYO, B.; Pertumbuhan Jaringan dan Kelompok Otot Baku Kambing Kacang berdasarkan Persamaan Allometrik [The Growth Rate of Tissues and Standard Muscle Groups of Kacang Goats Based on an Allometric Equation]; Proceeding Pertemuan Ilmiah Ruminansia Kecil; Bogor, November 22-23; 1983; [Indonesian].

SUMARTI; Studi Penampilan Kambing Kacang di daerah Semarang [Study on Kacang Goat Performance in Semarang]; Laporan Penelitian; Universitas Diponegoro, Semarang; 91; [Indonesian].

SUTAMA, I. K.; Puberty and Early Reproductive Performance of Peranakan Etawah Goat; in: *Proceedings of the 7th AAAP Animal Science Congress, July 11-16*; Bali; 1994.

TAWFIK, E. T.; Basic Concept of Animal Breeding; Paper Presented at General Lecture in Jenderal Soedirman University; Puwokerto, Indonesia, September 29; 2001.

TRIWULANINGSIH, E.; Pertumbuhan Kambing Peranakan Etawah sampai Umur Satu Tahun [Growth Rate of Peranakan Etawah Goats till One Year of Age]; Pertemuan Ilmiah Penelitian Ruminansia; Bogor, August; 1989.

UMIYASIH, U., KOMARUDIN, M. and YUSRAN, M. A.; Karakteristik Karkas Kambing Peranakan Etawah pada Berbagai Umur Pemotongan [Carcass Characteristics of Peranakan Etawah]; Prosiding Lokakarya Potensi dan Pengembangan Ternak Kambing di Wilayah Indonesia Bagian Timur; Surabaya, 28-29 July; 1993; [Indonesian].

UTOYO, D. P.; Animal Genetic Resources in Indonesia: A Country Report; in: *Proceedings of the First National Co-ordinators Meeting on Conservation and Use of Animal Genetic Resources in Asia and the Pacific, January 1995*; FAO, Bangkok,; 1995.

WAHYUNI, S. and SUPARYANTO, A.; Changes in Women's Small Ruminant Management and Impact on Family Labour Pattern; in: *Proceeding of the International Seminar, October 1991*; Brawijaya University, Malang, Indonesia; 1991.

WINUGROHO, M., SASTRADIPRAJA, D. and YOUNG, B. A.; *Adaptasi Ternak Ruminansia Kecil terhadap Kondisi Tropis [Adaptation of Small Ruminants to Tropical Indonesia]*; UNS-Press, Surakarta, Indonesia; 1994; pp.467. [Indonesian].

YULISTIANI, D., TIENAMURTI, B., ADIATI, U., PRIYANTI, A. and SETIYANTO, H.; Optimalisasi Usaha Ternak Kambing dan Domba sebagai Upaya Meningkatan Efisiensi Usaha [Optimalisasion of Raising Goat and Sheep to Improve the Enterprise Efficiency]; Seminar Nasional Peternakan dan Veteriner, Bogor, Oct.; 1998; [Indonesian].

YUSRAN, M. A., WIJONO, D. B. and WARDHANI, N. K.; Variasi Prestasi Reproduksi Kambing Peranakan Etawah di Dua Desa Berbeda Agro Ekosistem [Variation of Reproduction Performance of Peranakan Etawah goats at Different Agro-Ecosystems]; Prosiding Seminar Pengembangan Peternakan dalam Menunjang Pembangunan Ekonomi Nasional. Jenderal Soedirman University, Purwokerto, May 4; 1991; [Indonesian].

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Bericht über die Sonderausstellung „Deutschsprachige Lehr- und Handbücher zur Agrarwirtschaft in den Tropen und Subtropen aus 12 Jahrzehnten“ aus den Beständen der Bibliothek des Deutschen Instituts für tropische und subtropische Landwirtschaft (DITSL) in Witzenhausen

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Keywords: Text- and handbooks exhibition, agriculture in the tropics and subtropics
Stichworte: Lehr- und Handbuchausstellung, Agrarwirtschaft in den Tropen und Subtropen

1 Einführung

Anlässlich des Deutschen Tropentages 2002, der hundertjährigen Wiederkehr der Errichtung des ersten Gewächshauses für tropische Nutzpflanzen in Witzenhausen, des Tages der Kulturpflanze und der Kürbismesse präsentierte die Bibliothek des Deutschen Instituts für tropische und subtropische Landwirtschaft (DITSL) im Oktober 2002 eine Sonderausstellung zum Thema „Deutschsprachige Lehr- und Handbücher zur Agrarwirtschaft in den Tropen und Subtropen“.

Die Ausstellung zeigte über 80 der von 1876 bis heute erschienenen deutschsprachigen Lehr- und Handbücher (Anlage 1). Darüber hinaus wurden beispielhaft einige Exemplare der Zeitschrift „Der Tropenpflanzer“ und ihrer Beihefte ausgestellt. Diese Zeitschrift einschließlich ihrer Beihefte wurde von 1897 bis 1944 vom Kolonial-Wirtschaftlichen Komitee herausgeben. Sie stellte eine wesentliche, oft die einzige fachliche Informationsquelle dar für alle, die sich mit der kolonialen Landwirtschaft befassten. Sie ergänzte und aktualisierte das in den Lehr- und Handbüchern festgehaltene Wissen zur Agrarwirtschaft in den Tropen und Subtropen. Aus Platzmangel konnten die zahlreichen vor allem nach 1955 erschienen Monographien zu speziellen Fragestellungen nicht ausgestellt werden. Dabei hätten es viele durchaus verdient, in einer solchen Ausstellung präsentiert zu werden. Als Beispiel sei die Monographienreihe über wirtschaftlich bedeutende tropische Nutzpflanzen genannt, die von der Firma Ruhrstickstoff herausgegeben wurde. Diese ersetzte bis Ende der 60er Jahre oft die fehlenden aktuellen Lehrbücher.

2 Aufgabe und Bedeutung von Lehr- und Handbüchern

Die Ausstellung wollte dem Besucher vermitteln, dass Lehr- und Handbücher auch früher unentbehrliche Hilfsmittel für Lehrende und Lernende gewesen sind. Sie dienten der

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Vorbereitung auf berufliche und andere Tätigkeiten, die besonderer und spezialisierter Kenntnisse und Fertigkeiten bedurften. Die Bedeutung der Lehrbücher, vor allem aber der Handbücher bleibt über die Ausbildung hinaus auch während der Berufsausübung erhalten. Dies trifft nicht zuletzt für Tätigkeiten in der Agrarwirtschaft der Tropen und Subtropen zu, denn oft liegen die Tätigkeitsfelder weit von den Informationszentren entfernt und der Zugang zu fachlichen Informationen ist nicht selten erschwert. Auch im Zeitalter des Internet trifft dies noch immer zu. Heute werden zunehmend „Lehrbücher" in elektronischer Form angeboten, kaum aber für Spezialgebiete, wie es die Landwirtschaft in den Tropen und Subtropen darstellt.

Im Gegensatz zu den Handbüchern. d.h. den systematisch und lexikalisch aufgebauten Nachschlagewerken eines bestimmten Sachgebietes, sind Lehrbücher sachgerechte, systematisch und didaktisch aufgebaute Darstellungen eines Wissensgebietes. Lehrbücher sind i.d.R. unter Berücksichtigung lernpsychologischer Erkenntnisse, auf die jeweilige Stufe der Ausbildung ausgerichtet. An dieser Definition müssen sich die einzelnen Lehr- und Handbücher und insbesondere deren Autoren im Hinblick auf das vorgelegte Produkt messen lassen. Eine entsprechende Wertung der ausgestellten Lehr- und Handbücher hätte allerdings den Rahmen der Ausstellung gesprengt.

3 Die Ausstellung

3.1 Konzept und Umsetzung

Die nunmehr über 100 Jahre alte Bibliothek des Deutschen Instituts für tropische und subtropische Landwirtschaft, die auf die Agrarwirtschaft in den Tropen und Subtropen spezialisiert ist, verfügt heute neben den wichtigsten Fachzeitschriften über einen Buchbestand von ca. 40.000 Bänden. Von den Anfängen bis heute diente die Sammlung vornehmlich der Literaturversorgung der Teilnehmer und Teilnehmerinnen von Aus- und Weiterbildungsmaßnahmen am Standort Witzenhausen, sowie den dort tätigen Agrarwissenschaftlern. Entsprechend befindet sich im Bestand der Bibliothek eine weitgehend vollständige Sammlung aus unterschiedlichen Zeitepochen. Im Vergleich sind die Lehr- und Handbücher eine Fundgrube für die historische Betrachtung der Entwicklung des Sachgebietes einschließlich der Forschunsschwerpunkte und -ansätze.

Zur Darstellung der historischen Entwicklung der deutschsprachigen Lehr- und Handbücher der Agrarwirtschaft in den Tropen und Subtropen wurden diese in den Kontext der zeitgeschichtlichen Entwicklung gestellt. Damit ergab sich folgendes Ordnungsschema:

(a) die deutsche Vorkolonialzeit (<1884);

(b) der Zeitraum der deutschen Kolonialzeit (1884-1918);

(c) der Zeitraum der „Nachkolonialzeit" (1919-1945) und

(d) der Zeitraum der Entwicklungszusammenarbeit (1955 bis heute).

Über 80 Lehr- und Handbücher wurden aus dem Bestand der Bibliothek des Deutschen Instituts für tropische und subtropische Landwirtschaft ausgewählt und den Besuchern zur Einsicht präsentiert. Beispielhaft für die vorkoloniale Zeit wurde das Werk von Zippel

mit seinen drei „Abteilungen“ ausgestellt. Die Kolonialzeit war mit 28, die nachkoloniale Zeit mit 21 und die Zeit der Entwicklungszusammenarbeit mit 29 Lehr- und Handbüchern vertreten. Die bibliographischen Angaben zu den ausgestellten Lehr- und Handbüchern finden sich im Anhang.

Die Ausstellung wollte die Besucher aber nicht nur mit den Lehr- und Handbüchern selbst vertraut machen, sondern auch mit den Autoren. Kurzbiographien, soweit die entsprechenden Daten zu ermitteln waren, ergänzten die Präsentation der Werke.

3.2 Erkenntnisgewinn: Lehr- und Handbücher sind mehr als nur Fachbücher

Während der Vorbereitungen zur Ausstellung wurde sehr bald deutlich, dass Lehr- und Handbücher verschiedener Zeitepochen mehr sind als nur Fachbücher. Sie sind Spiegelbilder des Interesses an einem Wissens- bzw. Sachgebiet, des technischen und wissenschaftlichen Fortschritts einer Epoche und der Entwicklung und des Wandels agrarwirtschaftlicher Methoden. Auf Schrifttafeln wurde dieser Tatbestand erläutert. So konnten die Besucher bei der vergleichenden Betrachtung der Werke unterschiedlicher Zeitepochen unschwer die Entwicklung einzelner Fach- und Sachgebiete nachvollziehen und vielfältige, über das spezifische Fachwissen hinausgehende Erkenntnisse gewinnen.

Lehr- und Handbücher sind verständlicherweise immer dann verfasst und verlegt worden, wenn bei einer größeren Gruppe von Menschen ein Bedarf für den Erwerb und die Vermittlung von Kenntnissen und Fertigkeiten vorlag. Das Spektrum und die Vielzahl der in einer Zeitepoche verlegten Lehr- und Handbücher belegt damit das allgemeine Interesse an den Wissens- bzw. Sachgebieten zu dieser Zeit. So stieg z.B. die Nachfrage nach deutschsprachigen Lehr- und Handbüchern zur Agrarwirtschaft in den Tropen und Subtropen mit dem Eintritt Deutschlands in den Kreis der Kolonialmächte ab 1884 sprunghaft an. Es flachte naturgemäß während des ersten Weltkrieges deutlich ab. Doch schon bald danach nahm das Interesse wieder zu. Ursache war die faktisch bis 1945 in weiten Kreisen genährte Hoffnung auf Rückgabe der Kolonien. Danach fiel das Interesse auf einen Nullpunkt. Mitte der fünfziger Jahre, als im politischen und wirtschaftlichen Geschehen die Entwicklungsländer eine immer größere Rolle zu spielen begannen, nahm die Zahl der herausgegebenen Lehr- und Handbücher wieder zu. Das Interesse an und die Beschäftigung mit der Agrarwirtschaft in den Tropen und Subtropen stieg danach ständig. In jüngster Zeit ist wieder ein Rückgang in der Zahl der verlegten deutschsprachigen Lehr- und Handbücher zu beobachten. Dieser verläuft parallel zur Abnahme der Zahl der Agrarstudenten an deutschen Hochschulen, die sich für Tätigkeiten in tropischen/subtropischen Regionen interessieren bzw. dort berufliche Chancen sehen. Dieser Rückgang hängt ohne Zweifel auch damit zusammen, dass die englische Sprache in der Kommunikation der Entwicklungszusammenarbeit und der internationalen Agrarforschung eine vorherrschende Stellung eingenommen hat. Als Folge davon werden heute Lehr- und Handbücher auch von deutschsprachigen Autoren zunehmend in Englisch verfasst.

Als Spiegelbilder des technischen und wissenschaftlichen Fortschritts einer Epoche vermitteln Lehr- und Handbücher eine sachgerechte und systematische Darstellung eines Wissens- bzw. Sachgebietes auf der Grundlage des Erkenntnisstandes, wie er zum Zeit-

punkt des Abfassens vorlag. So baute beispielsweise Semler (1886-1888) sein Handbuch noch weitgehend auf seinen eigenen Erfahrungen und Beobachtungen während seiner Forschungsreisen auf. Wohltmann (1891) dagegen unternahm es mit seinem Handbuch der Tropischen Agrikultur, dieses Sachgebiet allgemein von einer mehr wissenschaftlichen Seite aus zu beleuchten. Seine entsprechenden Versuche im 1. Band seines Handbuches sind allerdings noch sehr vorsichtig und nicht immer überzeugend ausgefallen. Leider ist der geplante zweite Band nie erschienen. Die Ursache dürfte vor allem im Mangel an wissenschaftlich belegten Erkenntnissen liegen. Vermutlich war aber auch schon damals ein einzelner Autor überfordert, als Einzelner ein Handbuch eines so umfangreichen Sachgebietes, wie es die Agrarwirtschaft in den Tropen und Subtropen darstellt, herauszugeben.

Erst mit der Entwicklung des landwirtschaftlichen Versuchswesens in den Tropen und Subtropen fanden zunehmend wissenschaftliche Erkenntnisse Eingang. Dies belegt das von Schmidt und Marcus 1943 herausgegebene zweibändige Handbuch der tropischen und subtropischen Landwirtschaft, das wesentlich fundierter ausfiel. Die beiden Herausgeber wurden von vierzig Mitautoren unterstützt, die als Spezialisten die Bearbeitung einzelner Sachgebiete übernahmen. Die große Zahl der Mitautoren macht zugleich die beachtliche Zunahme deutschsprachiger Spezialisten deutlich. Auch die im Unterschied zu Semler und Wohltmann bei Schmidt und Marcus wesentlich umfangreicheren Literaturangaben dokumentieren die Zunahme wissenschaftlich begründeter Erkenntnisse. Ein Vergleich des Handbuchs von Schmidt und Marcus mit der 2. Auflage des Handbuchs von Blanckenburg und Cremer (1982/1998) zeigt den enormen technisch-wissenschaftlichen Fortschritt, den die Agrarwirtschaften in den Tropen und Subtropen, vor allem in der zweiten Hälfte des 20. Jahrhunderts, durchlaufen haben. Allerdings wird auch deutlich, wieviele Probleme nach wie vor einer Lösung harren.

Ebenso zeigt der Vergleich der Lehr- und Handbücher über die Zeit, wie die tropische Landwirtschaft im Verlauf des 20. Jahrhunderts sich von einer rein empirischen Wirtschaftsweise auf wissenschaftlich begründete Methoden umstellte. Nach dem ursprünglich praktizierten Raubbau begann sie sich Schritt für Schritt rationellen Wirtschaftsmethoden zuzuwenden. In der landwirtschaftlichen Forschung waren die seit langer Zeit im Besitz der Engländer und Holländer befindlichen Kolonien zunächst führend. Deutschland versuchte Anschluss zu gewinnen, indem es sich zunächst die vorliegenden Erfahrungen und wissenschaftlichen Erkenntnisse zu Nutze machte. Dabei übernahm das Kolonial-Wirtschaftliche Komitee seit der Jahrhundertwende bis zum zweiten Weltkrieg eine führende Rolle. Es organisierte und finanzierte zahlreiche fachwissenschaftliche Expeditionen und Studienreisen und publizierte die Ergebnisse.

Insgesamt bewirkten die in den Publikationen zusammengefassten Erfahrungen und Erkenntnisse einen stetigen Wandel der Landnutzung in den Tropen und Subtropen. Allerdings kann dieser nicht immer positiv bewertet werden. So zeigen die Lehr- und Handbücher auch, dass die Entwicklung der agrarwirtschaftlichen Methodik nicht immer im Einklang mit ökologischen, wirtschaftlichen und sozialen Erfordernissen einer nachhaltigen Landnutzung in den Tropen und Subtropen stand. Die internationalen

Bemühungen diesen Mangel zu beseitigen nehmen in jüngerer Zeit einen herausragenden Platz in den Lehr- und Handbüchern ein.

Anlage 1

Ausgestellte deutschsprachige Lehr- und Handbücher zur Agrarwirtschaft in den Tropen und Subtropen

Lehr- und Handbücher der vorkolonialen Zeit ($<$ 1884)

Zippel, H., 1876: Ausländische Kulturpflanzen : in farbigen Wandtafeln mit erläuterndem Text. Zeichnungen von K. Bollmann. - Druck und Verlag von Friedrich Vieweg und Sohn, Braunschweig
1. Abteilung Text. 1876 (4., neu bearbeitete Aufl. 1899)
2. Abteilung Text. (3., vielfach verbesserte und vermehrte Aufl. 1986)
3. Abteilung Text. 1889

Lehr- und Handbücher der Kolonialzeit (1884-1919)

Freiherr von Hammerstein, 1886: Der tropische Landbau. Anleitung zur Plantagenwirtschaft und zum Anbau der einzelnen tropischen Kulturgewächse mit besonderer Rücksicht auf die deutschen Kolonien.- Verlag Paul Parey, Berlin

Semler, H., 1886: Die Tropische Agricultur. Ein Handbuch für Pflanzer und Kaufleute.- 1. Band. Hinstorff'sche Hofbuchhandlung, Wismar

Semler, H., 1887: Die Tropische Agricultur. Ein Handbuch für Pflanzer und Kaufleute.- 2. Band. Hinstorff'sche Hofbuchhandlung, Wismar

Semler, H., 1888: Die Tropische Agricultur. Ein Handbuch für Pflanzer und Kaufleute.- 3. Band. Hinstorff'sche Hofbuchhandlung, Wismar

Semler, H., 1892: Die Tropische Agricultur. Ein Handbuch für Pflanzer und Kaufleute.- 4. Band. Hinstorff'sche Hofbuchhandlung, Wismar (Dieser Band wie auch die zweite Auflage von Hindorf und Warburg herausgegeben.)

Rieck, H., 1887: Praktische Anleitung zur Kultivation subtropischer Gebiete, nach eigener Erfahrung, besonders in Südost-Australien.- Verlag R. Oldenbourg, München und Leipzig

Wohltmann, F., 1892: Handbuch der Tropischen Agrikultur für die deutschen Kolonien in Afrika auf wissenschaftlicher und praktischer Grundlage. Band 1: Die natürlichen Faktoren der tropischen Agrikultur und die Merkmale ihrer Beurteilung.- Leipzig (ein zweiter Band ist nicht erschienen)

Engler, A., 1895: Die Pflanzenwelt Ost-Afrikas und der Nachbargebiete. Deutsch-Ost-Afrika. Wissenschaftliche Forschungsresultate über Land und Leute unseres ostafrikanischen Schutzgebietes und der angrenzenden Länder. Band 5.- Geographische Verlagshandlung Dietrich Reimer, Berlin

Theil A. Grundzüge der Pflanzenverbreitung in Deutsch-Ost-Afrika und den Nachbargebieten

Theil B. Die Nutzpflanzen Ost-Afrikas (Hrsg. A. Engler)

Theil C. Verzeichniss der bis jetzt aus Ost-Afrika bekannt gewordenen Pflanzen (Hrsg. A. Engler)

Sadebeck, R., 1899: Die Kulturgewächse der deutschen Kolonien und ihre Erzeugnisse.- Verlag Gustav Fischer, Jena

Hermann, E., 1900: Viehzucht und Bodenkultur in Südwestafrika. Zugleich Ratgeber für Auswanderer. - Deutscher Kolonial-Verlag, Berlin

Rackow, H., 1900: Tropische Agricultur. Praktische Anleitung zur Beschaffung und Anwendung der Gebrauchsgegenstände für den tropischen Ackerbau.- Deutscher Kolonial-Verlag (G. Meinecke), Berlin

Warburg, O., 1900: Die Kautschukpflanzen und ihre Kultur.- Selbstverlag Kolonial-Wirtschaftliches Komitee, Berlin

Müller, R., 1903: Studien und Beiträge zur Geographie der Wirtschaftstiere. 1. Band Die geographische Verbreitung der Wirtschaftstiere mit besonderer Berücksichtigung der Tropenländer.- Verlag von M. Heinsius Nachfolger, Leipzig

Kindt, L., 1904: Die Kultur des Kakaobaumes und seine Schädlinge.- Verlag von C. Boysen, Hamburg

Wohltmann, F., 1904: 120 Kultur- und Vegetationsbilder aus unseren deutschen Kolonien. - Wilhelm Süsserott, Berlin

Zietlow, E., 1904: Subtropische Agrikultur. Ein Handbuch für Kolonisten und Pflanzer.- Verlag Dr. Seele & Co., Leipzig

Fesca, M., 1904: Der Pflanzenbau in den Tropen und Subtropen, Teil 1. - Band 7 Süsserotts Kolonialbibliothek. Verlag von Wilhelm Süsserott, Berlin

Fesca, M., 1907: Der Pflanzenbau in den Tropen und Subtropen, Teil 2. - Band 8 Süsserotts Kolonialbibliothek. Verlag von Wilhelm Süsserott, Berlin

Fesca, M., 1911: Der Pflanzenbau in den Tropen und Subtropen, Teil 3. - Band 20 Süsserotts Kolonialbibliothek. Verlag von Wilhelm Süsserott, Berlin

Tobler, Fr., 1907: Kolonialbotanik.- Bändchen 184 Aus Natur und Geisteswelt. Sammlung wissenschaftlich-gemeinverständlicher Darstellungen. Druck und Verlag von B.G. Teubner, Leipzig

Rickmann, W., 1908: Tierzucht und Tierkrankheiten in Deutsch-Südwestafrika. - Verlagsbuchhandlung von Richard Schoetz, Berlin

Warburg, O. und J.E. van Someren-Brand (Hrsg.), 1908: Kulturpflanzen der Weltwirtschaft. - Voigtländer, Leipzig

Winkler, H., 1912: Botanisches Hilfsbuch für Pflanzer, Kolonialbeamte, Tropenkaufleute und Forschungsreisende.- Hinstorff, Wismar

Schlettwein, C., 1913: Viehzucht in den Tropen und Subtropen.- Süsserotts Kolonialbibliothek Band 26. Wilhelm Süsserott, Berlin

Sokolowsky, A., 1913: Die Tierwelt der Tropen und ihre Verwertung.- Verlag Fr. W. Thaden, Hamburg

Fruwirth, C., 1914: Die Züchtung kolonialer Gewächse.- Band V des Handbuches der landwirtschaftlichen Pflanzenzüchtung von C. Fruwirth. (Die zweite, gänzlich neubearbeitete Auflage erschien 1923).- Verlagsbuchhandlung Paul Parey, Berlin

Schröter, K., 1914: Die Haustierzucht in den Tropen und Subtropen.- Deutsche Tropen-Bibliothek Bd. 6. Verlag von Fr. W. Thaden, Hamburg

Zacher, F., 1914: Die wichtigsten Krankheiten und Schädlinge der tropischen Kulturpflanzen und ihre Bekämpfung. Band 1.- Verlag Fr. W. Thaden, Hamburg

Lehr- und Handbücher der nachkolonialen Zeit (1919-1945)

Mense, C. (Hrsg.), 1921: Handbuch der Tropen-Krankheiten (2. Aufl.) Band 6: Knuth, P. und P. J. du Toit: Tropen-Krankheiten der Haustiere.- Verlag von Johann Amborsius Barth, Leipzig

Sabalitschka, Th., 1923: Heil, Genuß-, Gewürz- und Farbstoffe aus den Tropen und ihre Veredelung.- Sammlung Göschen Nr. 874. Verlag Walter de Gruyter & Co., Berlin und Leipzig

Hindorf, R., 1925: Der Sisalbau in Deutsch-Ostafrika.-Dietrich Reimer, Berlin

Zimmermann, A., 1926: Kaffee.- Bangerts Ausland-Bücherei Nr. 27, Reihe Wohltmann-Bücher Bd. 4. Deutscher Auslandsverlag Walter Bangert, Hamburg

Sprecher von Bernegg, A., 1929: Tropische und subtropische Weltwirtschaftspflanzen : ihre Geschichte, Kultur und volkswirtschaftliche Bedeutung. I. Teil Stärke- und Zuckerpflanzen.- Verlag von Ferdinand Enke, Stuttgart

Sprecher von Bernegg, A., 1929: Tropische und subtropische Weltwirtschaftspflanzen : ihre Geschichte, Kultur und volkswirtschaftliche Bedeutung. II. Teil Ölpflanzen.- Verlag von Ferdinand Enke, Stuttgart

Sprecher von Bernegg, A., 1934: Tropische und subtropische Weltwirtschaftspflanzen : ihre Geschichte, Kultur und volkswirtschaftliche Bedeutung. III. Teil Genusspflanzen, 1. Band Kakao und Kola.- Verlag von Ferdinand Enke, Stuttgart

Sprecher von Bernegg, A., 1934: Tropische und subtropische Weltwirtschaftspflanzen : ihre Geschichte, Kultur und volkswirtschaftliche Bedeutung. III. Teil Genusspflanzen, 2. Band Kaffee und Guaraná .- Verlag von Ferdinand Enke, Stuttgart

Sprecher von Bernegg, A., 1936: Tropische und subtropische Weltwirtschaftspflanzen : ihre Geschichte, Kultur und volkswirtschaftliche Bedeutung. III. Teil Genusspflanzen, 3. Band Der Teestrauch und der Tee. Die Mate- oder Paraguayteepflanze.- Verlag von Ferdinand Enke, Stuttgart

Arnold, G., 1930: Neues Handbuch der Tropischen Agrikultur. 1. Band: Die Grundlagen und die Bewirtschaftung von Tropenfarmen.- Tropenverlag Fr. W. Thaden, Hamburg

Arnold, G., 1930: Neues Handbuch der Tropischen Agrikultur. 2. Band. Tropenverlag Fr. W. Thaden, Hamburg

Arnold, G., 1930: Neues Handbuch der Tropischen Agrikultur. 3. Band. Tropenverlag Fr. W. Thaden, Hamburg

Vageler, P., 1930: Grundriss der tropischen und subtropischen Bodenkunde für Pflanzer und Studierende. - Verlagsges. für Ackerbau, Berlin

Feldmann, W., 1941: Leitfaden für den Pflanzenbau in den Tropen und Subtropen. Bd. 1, Allgemeine Anbaubedingungen in den Tropen und Subtropen.- Verlag Eugen Ulmer, Stuttgart (mehr nicht erschienen)

Obst, E. (Hrsg.), 1941: Afrika. Handbuch der praktischen Kolonialwissenschaften.- Band IX: Ostertag, R. von und G. Kulenkampff, 1941: Tierseuchen und Herdenkrankheiten in Afrika.- Verlag Walter de Gruyter & Co., Berlin

Obst, E. (Hrsg.), 1942: Afrika. Handbuch der praktischen Kolonialwissenschaften.- Band VIII: Schmidt, Geo A.; Marcus, A.; Böckler, W.; Berger-Landefeldt, U. und W. Unteutsch, 1942: Die landwirtschaftlichen Nutzplanzen Afrikas.- Morstatt, H., 1942: Krankheiten und tierische Schädlinge der Nutzpflanzen Afrikas.- Verlag Walter de Gruyter & Co., Berlin

Tobler, F. und H. Ulbricht, 1942: Koloniale Nutzpflanzen. Ein Lehr- und Nachschlagebuch.- Verlag S. Hirzel, Leipzig

VDI (Hrsg.), 1942: Tropen- und Kolonialtechnik in 27 Beiträgen.- VDI-Verlag, Berlin

Schmidt, G.A. und A. Marcus, 1943 (Hrsg.): Handbuch der tropischen und subtropischen Landwirtschaft, 1. Band.- Verlag von E.S. Mittler & Sohn, Berlin

Schmidt, G.A. und A. Marcus, 1943 (Hrsg.): Handbuch der tropischen und subtropischen Landwirtschaft, 2. Band.- Verlag von E.S. Mittler & Sohn, Berlin

Staffe, A., 1944: Die Akklimatisation der Haustiere in den afrikanischen Tropen.- Kolonialwissenschaftliche Forschungen Band 4. Verlag von E. S. Mittler & Sohn, Berlin

Lehr- und Handbücher in der Zeit der Entwicklungszusammenarbeit (1955 bis heute)

Boettger, C. R., 1958: Die Haustiere Afrikas. Ihre Herkunft, Bedeutung und Aussichten bei der weiteren wirtschaftlichen Erschließung des Kontinents.- VEB Gustav Fischer Verlag, Jena

Piekenbrock, P., 1958: Vegetation und Pflanzenbau in den Tropen.- Nr. 7 der Schriftenreihe der Deutschen Afrika-Gesellschaft. Selbstverlag Deutsche Afrika-Gesellschaft, Bonn

Esdorn, I., 1961: Die Nutzpflanzen der Tropen und Subtropen der Weltwirtschaft.- Stuttgart (2. Auflage mit Helmut Pirson 1973)

Fröhlich, G., 1963: Pflanzenschutz in den Tropen. Wissenschaftliche Zeitschrift der Karl-Marx-Universität Leipzig Mathematisch-Naturwissenschaftliche Reihe Sonderband III- VEB Offizin Andersen Nexö, Leipzig (2. neubearbeitete und erweiterte Auflage erschien 1974 bei Harri Deutsch, Zürich)

Kreeb, K., 1964: Ökologische Grundlagen der Bewässerungskulturen in den Subtropen.- Gustav Fischer Verlag, Stuttgart

Andreae, B., 1965: Die Bodenfruchtbarkeit in den Tropen. Nutzbarmachung und Erhaltung. Betriebswirtschaftliche Überlegungen für die Arbeit in Entwicklungsländern.- Verlag Paul Parey, Hamburg und Berlin

Blanckenburg, P.v. und H.D. Cremer, 1967: Handbuch der Landwirtschaft und Ernährung in den Entwicklungsländern. Bd. 1: Landwirtschaft in der wirtschaftlichen Entwicklung. Ernährung.- Verlag Ulmer, Stuttgart

Blanckenburg, P.v. und H.D. Cremer, 1967: Handbuch der Landwirtschaft und Ernährung in den Entwicklungsländern. Bd. 2: Pflanzliche und tierische Produktion in den Tropen und Subtropen.- Verlag Ulmer, Stuttgart

Franke, G., 1967: Nutzpflanzen der Tropen und Subtropen. Band I: Genußmittelliefernde Pflanzen. Kautschuk- und gummiliefernde Pflanzen. Öl- und fettliefernde Pflanzen. Knollen und Wurzelfrüchte.- S. Hirzel Verlag, Leipzig (2. Auflage 1974, 3. Auflage 1979, 4. Aufl. 1982)

Franke, G., 1967: Nutzpflanzen der Tropen und Subtropen. Band II: Getreide. Obstliefernde Pflanzen. Faserpflanzen.- S. Hirzel Verlag, Leipzig (2. Aufl. 1976, 3. Aufl. 1981, 4. Aufl. 1984)

Franke, G. (Hrsg.), 1978: Nutzpflanzen der Tropen und Subtropen. Band III: Pätzold, H.: Grasland und Feldfutterbau.- S. Hirzel Verlag, Leipzig (2. Aufl. 1986)

Franke, G. (Hrsg.), 1980: Nutzpflanzen der Tropen und Subtropen. Band IV: Fuchs, A.: Pflanzenzüchtung.- S. Hirzel Verlag, Leipzig (2. Aufl. 1984)

Schütt, P., 1972: Weltwirtschaftspflanzen. Herkunft, Anbauverhältnisse, Biologie und Verwendung der wichtigsten landwirtschaftlichen Nutzpflanzen.- Verlag Paul Parey, Berlin und Hamburg

Franke, W., 1976: Nutzpflanzenkunde. Nutzbare Gewächse der gemäßigten Breiten, Subtropen und Tropen.- Georg Thieme Verlag, Stuttgart und New York (2. Auflage 1981, 3. Auflage 1985, 4. Auflage 1989, 5. Auflage 1992, 6. Auflage 1997)

Rehm, S. und G. Espig, 1976: Die Kulturpflanzen der Tropen und Subtropen.- Ulmers Taschenhandbücher. Verlag Ulmer, Stuttgart (gebunden als 2., neubearbeitete Auflage 1984, 3., neubearbeitete Aufl. 1996)

Andreae, B., 1977: Agrargeographie. Strukturzonen und Betriebsformen in der Weltlandwirtschaft.- Walter de Gruyter, Berlin und New York (Zweite, überarbeitete und stark erweiterte Auflage 1983)

Brücher, H., 1977: Tropische Nutzpflanzen. Ursprung, Evolution und Domestikation.- Springer-Verlag, Berlin, Heidelberg, New York

Kranz, J.; Schmutterer, H. und W. Koch, 1979: Krankheiten, Schädlinge und Unkräuter im tropischen Pflanzenbau.- Verlag Paul Parey, Berlin und Hamburg

Krause, R. und F. Lorenz, 1979: Bodenbearbeitung in den Tropen und Subtropen.- Herausgegeben von Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, Eschborn

Achtnich, W., 1980: Bewässerungslandbau. Agrotechnische Grundlagen der Bewässerungslandwirtschaft.- Verlag Ulmer, Stuttgart

Andreae, B., 1980: Weltwirtschaftspflanzen im Wettbewerb. Ökonomischer Spielraum in ökologischen Grenzen. Eine produktbezogene Nutzpflanzengeographie.- Walter de Gruyter, Berlin und New York

Blanckenburg, P.v. und H.-D. Cremer (Hrsg. des Gesamtwerkes): Handbuch der Landwirtschaft und Ernährung in den Entwicklungsländern.- Verlag Eugen Ulmer, Stuttgart

Bd. 1: Blanckenburg, P.v.(Hrsg.), 1982: Sozialökonomie der ländlichen Entwicklung.
Bd. 2: Cremer, H.-D. (Hrsg.), 1983: Nahrung und Ernährung.
Bd. 3: Rehm, S. .(Hrsg.), 1985. Grundlagen des Pflanzenbaues in den Tropen und Subtropen.
Bd. 4: Rehm, S. .(Hrsg.), 1988: Spezieller Pflanzenbau in den Tropen und Subtropen.
Bd. 5: Horst, P. und I. Reh, 1998: Tierzucht in den Tropen und Subtropen.

Legel, S. (Hrsg.): Nutztiere der Tropen und Subtropen.- S. Hirzel Verlag, Leipzig und Stuttgart

Bd. 1, 1989: Rinder
Bd. 2, 1990: Büffel, Kamele, Schafe, Ziegen, Wildtiere
Bd. 3, 1993: Pferde/Esel, Schweine, Elefanten, Geflügel, Bienen, Seidenspinner

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Buchbesprechungen

Karl Hammer, Thomas Gladis, Marina Hethke (Hrsg.); 2003

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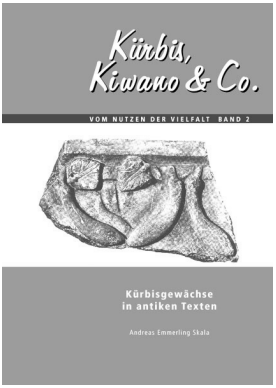

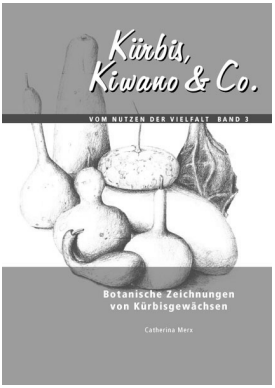

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Der sehr informative und mit Abbildungen und ausgezeichneten Fotos reich ausgestattete Katalog geht auf eine vielseitige Ausstellung und Tagung zum Thema zurück, die der Verein zur Erhaltung der Nutzpflanzenvielfalt (VEN) und das Fachgebiet Agrobiodiversität der Universität Kassel zusammen mit zahlreichen Vereinen, Verbänden, Botanischen Gärten, dem Völkerkundemuseum und der Stadt im Oktober 2002 in Witzenhausen organisiert hatten. Der überwältigende Erfolg dieser Veranstaltung beruhte auf langfristiger, solider Vorbereitung eines ausgesprochen breiten Programms zum populären Rahmenthema Kürbisgewächse, das bei der Lektüre dieser reizvollen Bände lebendig wird.

Das Spektrum der Beiträge reicht von zusammenfassenden Darstellungen zur Taxonomie, Verbreitung, Verwendung und Kulturgeschichte der genutzten und vierundsechzig angebauten Arten der Familie der Cucurbitaceae bis zu kurzen Aufsätzen über spezielle Fragen der Ethnobotanik, medizinischen Nutzung, Reproduktionsbiologie, Pflanzen-

ernährung, Züchtung und wirtschaftlichen Bedeutung. Mit den Kurzbiographien des Begründers des heutigen Instituts für Pflanzengenetik und Kulturpflanzenforschung (IPK) in Gatersleben, Hans Stubbe (1902-1989) und Igor Sergeevič Grebenščikovs (1912-1986), der an dieser Einrichtung wichtige Beiträge zur Systematik und Genetik der Kürbisgewächse geleistet hat und wesentlich zum Aufbau der umfangreichen Cucurbitaceen-Kollektion der Genbank Gatersleben beitrug, werden interessante wissenschaftshistorische Details der Kulturpflanzenforschung in Deutschland beleuchtet.
Sorgfältig recherchierte Informationen über Kürbisgewächse in Texten der griechischen und römischen Antike werden zusammen mit ausführlichen paläoethnobotanischen Daten sowie Angaben zur Geschichte von Nutzung und Kultur in einem gesonderten Band präsentiert. Der dritte Teil des Katalogs umfasst schließlich wissenschaftliche Pflanzenzeichnungen, die detailgetreu charakteristische Spross-, Blatt-, Blüten-, Frucht- und Samenmerkmale für achtzehn ausgewählte Kulturarten wiedergeben.
Der Katalog der Witzenhäuser Ausstellung ist beinahe so attraktiv wie seine pflanzlichen Objekte, und jede allgemeine, landwirtschaftlich/gartenbauliche oder botanische Bibliothek, jeder Biologielehrer, Natur- und Gartenfreund im deutschsprachigen Raum sollte ihn sich gönnen!

K. Pistrick, Gatersleben

Martius, C., Tiessen, H., Vlek, P. L. G. (Eds.); 2001

Managing Organic Matter in Tropical Soils: Scope and Limitations.
Kluwer Academic Publishers, Dordrecht, 2001. 235 pages,
ISBN 0-7923-6759-6, 125,– €.

This books contains the proceedings of a workshop organized by the Center for Development Research at the University of Bonn, Germany, 7-10 June 1999.
In their introduction the editors emphasize the importance of soil organic matter (SOM) not only as a source for plant available nutrients, but also for protection of soils against wind and water erosion, retention and filtration of water, or salinity reduction.
As a result of the workshop 3 questions were tried to be answered: 1) What are the most important priorities in SOM management and research?, 2) How can SOM research best be linked to practical application? and 3) What are the best entry points to develop a higher public awareness for the need of SOM management and research in the tropics?

To answer these questions, SOM experts give examples in 22 articles. Some of them deal with SOM in general, such as: a) The role of soil microorganisms and of the macrofauna on SOM conservation in the tropics, b) Modelling of tropical SOM, c) Translation of the theory of SOM in the tropics into practice, and d): Social, economic and policy factors associated with SOM. On the other hand, many articles describe special aspects of SOM in certain tropical regions of the world, e. g.: a) SOM development due to the climate (Ruanda, Cameroun, Burkina Faso), b) SOM development depending on different soil types (Lower Antilles), c) Different forms of OM supply in India, where emphasis is given to the influences of biogas, crop residues, cattle manure, straw, green manure or *Azolla*,

c) Mixed culture in Vietnam of cassava with peanut or *Tephrosia candida*, pineapple and vetiver hedgerows, maize or litchi with peanut, coffee with sesame or tea with *Tephrosia*. d) Different fertilizer applications are described for Bangla Desh, West Africa (especially: poultry manure), and also Southern Africa, where influences on SOM may be achieved through inorganic fertilization with legume intergration or through combined inorganic and organic inputs. e) SOM influenced by different cropping systems is reported for semiarid African cuntries and for Brezil. f) Case studies about nutrient fluxes on farms are described in Brazil and in Zimbabwe, and material flux analyses (especially for urbanic wastes) in Columbia.

The last article deals with history of SOM and an outlook. There are many examples that soils which had been fertile in ancient times, lost their fertility due to wrong soil management. After loss of SOM, erosion and salination turned fertile fields into eroded rocks throughout the Mediterranean area or into salt incrusted flats in Mesopotamia, and consequently human civilizations and empires died. The origin of the word "humus" (SOM) and the latin word "homo" (human being) is the same: If the soil is enriched with organic matter, it becomes a living body. Our task today should be to maintain the life of the soil, upon which we all depend.

The book is very expensive, but it gives an excellent overview about modern aspects of SOM. It offers a great deal of information to all persons involved with agriculture, soil science, plant nutrition and ecology in the tropics and subtropics.

C. Richter, Witzenhausen

Bollig, Michael and Jan-Bart Gewald (editors); 2000

People, Cattle and Land. Transformation of a Pastoral Society in Southwestern Africa.

540 pages, 17 maps, 16 colour photos, 17 b/w photos, 31 graphs and many tables. History, Cultural Traditions and Innovations in Southern Africa, Vol. 13. Rüdiger Köppe Verlag, Köln, 2000. ISBN 3-89645-352-1, hardcover bound, price: € 65,45.

The book compiles comprehensive interdisciplinary studies presented by 17 authors from the international scientific community on Herero, Himba and adjoining societies in Southwestern Africa. A wide array of topics is treated comprising origin, social and cultural characteristics and customs. Though, most of the early history of the Herero remains in the dark, knowledge deriving from comparisons of oral traditions and archaeological findings are being discussed. Nevertheless, there has been a remarkable openness to change and innovation in the more recent history. The Herero who, in pre-colonial times had engaged in numerous activities, of which herding was just one, have adopted pastoralism as a mainstay of their existence. Adapting to a hostile environment their social structure which originally was egalitarian became hierarchical with chiefs and warlords struggling for power.
After 1915, when the Herero had recovered from the genocidal war against imperial Germany the land issue gained importance. But the reserve policy of the South African Administration comprising tight control and enforced communal land tenure did not

satisfy their expectations and political agitation continuously gained ground, which finally lead to independent Namibia. At the same time income disparities increased along with the emergence of individually owned capitalist farms, commercialisation of livestock products and, on the other side, employed labour and landlessnes.
This extremely valuable book is not only of interest to anthropologists, but also to scholars and professionals of other disciplines who engage in research or development promotion in Africa. It is worth mentioning that the same is true for the series "History, Cultural Traditions and Innovations in Southern Africa" from the same publisher of which this book is Vol. No. 13. In, so far, 18 volumes cultural and landscape changes from early to recent history of arid Africa, with a regional focus on Southern Africa, are dealt with.

Eckhard Baum, Witzenhausen

Bollig, Michael and Tjakazapi Janson Mbunguha; 1997

"When War Came the Cattle Slept ..." Himba Oral Traditions
collected and translated by Michael Bollig in collaboration with Tjakazapi Janson Mbunguha.

People, Cattle and Land. Transformation of a Pastoral Society in Southwestern Africa. 337 pages, 2 maps, 13 b/w photos. History, Cultural Traditions and Innovations in Southern Africa, Vol. 1. Rüdiger Köppe Verlag, Köln, 1997. ISBN 3-89645-049-2, price: € 39,88.

Readers of this book should be aware of two facts: Firstly, it is only after independence and the end of apartheid in Southern Africa that Namibian historiography has got a chance to develop without political strings. Hence, much of pre-colonial knowledge may have been lost. Secondly, oral traditions are very much alive and their status within a society may change over time. Although oral traditions differ from written documentation, their reliability may not. Both do not necessarily reflect historical truth, but rather individual perceptions of past reality. Nevertheless, the collection of oral traditions from amongst the Herero speaking peoples of north-western Namibia and south-western Angola, as presented in this book, is a valuable contribution to a better understanding of cultural identities of this particular ethnic group.

After description of methods and a brief presentation of results the authors quote 12 authentic interviews in original language and English translation. The interviewed persons were selected in accordance with Himba sense of authority and their perception of who is entitled to recite oral traditions.

Memories of the interviewees reach back as far as the second half of the 19th century classified as the time of the Kuena Wars. They tell the stories of Conflicts with the Nama, of migrations into Southern Angola and of life with their matrilineal ancestors, there. Between 1900 and 1920 many Hima/Herero families moved back into Kaokoland in response to the establishment of Portuguese administration. Although Kaokoland had been bought by a mining company the territory was never exploited. Hence, the

nomadic inhabitants where relatively unmolested by the German colonial government. Interference grew when the South African administration attempted to disarm the people and to control cattle diseases by establishing tribal boundaries and separating native reserves from commercial farming areas. When these targets had been achieved by 1940 the people of Kaokoland had lost their options for long distance migrations and trade. They were forced back into subsistence pastoralism as a result of the restrictions enforced on them.

The highly relevant individual accounts of the interviewees are a valuable source of information for anthropologists as well as all those who have interest in indigenous cultures and African history.

Eckhard Baum, Witzenhausen

Erick J. Mann; 2002

Mikono ya damu: "Hands of Blood". African Mercenaries and the Politics of Conflict in German East Africa, 1888 - 1904.

334 p.,numerous tables, figures and maps. Peter Lang Verlag, Frankfurt, Berlin, Bern, Buuxelles, New York, Oxford, Wien, 2002. ISBN 3-631-37614-6. Price: 50.10 €

The work examines the history of the German military intervention in East Africa in the course of the so-called Arab Revolt of 1888. The author analyses sociology and vested economic interests of the groups involved in the conflict. Unlike early authors who mainly confined to describing events and battles of the Wissmann campaign, Mann focuses on an analysis of the background and status of Schutztruppe members who were free of any social ties and could act quite independently. Social and ethnic characteristics of their opponents, however, were considerably different and a rather poor basis for unified resistence. Coastal urban societies were dominated by local elites who liaised with Omani Arabs and jealously excluded newcomers from the hinterland from participating in the proceeds of the caravan trade. Only, when the DOAG agents attempted to seize political power and economic control by claiming sovereignty over the coastal towns, they caused tensions and dissatisfaction.

With the beginning of the caravan trade around 1830 the power structures along the big routes had changed considerably. Trader chiefs and "Big Men" had successfully competed with local authorities, regularly engaged in raids to obtain food from the local population which they traded for arms, and were eventually strong enough to raise tolls from passing caravans. Chieftains situated near the caravan routes were facing political dissent and social decay and could offer but little resistance to the Schutztruppe. Strong leadership which could successfully challenge German intervention, of which Mkawa of Hehe is the mist prominent example, were rather an exception. From these facts Mann argues that it was not technical and military superiority which eventually led to the conquest of Tanzania, but rather the desolate socio-economic conditions which had already emerged in pre-colonial times.

With respect to the origins of the revolt the author debates the thesis that it was primarily an Arab uprising, as was claimed by the bias of contemporary orientalist theories which viewed Africans as incapable of mounting an effective resistence. Instead, Mann argues that discontent mainly arose in those urban societies where Omani influence on the elites tended to be less. The diversity of leadership was shown by the fact that only one of the three most prominent leaders was an Omani Arab (Bana Heri), while Bushiri was a half-cast, not recognised by the Arabs, and the third, Machemba was a local Makonde Chief.

The book is a useful reference and worth reading for all those who are interested in colonial history, as well as in social and plitical history of Africa.

Eckhard Baum, Witzenhausen

Journal of Agriculture and Rural Development in the Tropics and Subtropics
Volume 104, No. 1, 2003, pages 107–110

Kurznachrichten

Kyoto Protokoll zum Klimaschutz

Neue Studie zeigt, dass Russland nicht vom Klimawandel profitiert
Wissenschaftler aus Kassel und Moskau empfehlen Russland die Ratifizierung des Kyotovertrags

Kassel/Moskau. Wenn Russland das Kyoto Protokoll zum Klimaschutz ratifiziert, wie Premierminister Mikhail Kasyanov es in Johannesburg auf dem Weltumweltgipfel versprochen hat, würde es damit einen ausschlaggebenden Beitrag zu seiner eigenen Nahrungsmittelsicherung und Wasserverfügbarkeit im kommenden Jahrhundert leisten. Dies zeigt eine neue Studie, die gemeinsam vom Wissenschaftlichen Zentrum für Umweltsystemforschung der Universität Kassel, der Fakultät für Geografie der Universität Moskau und dem Zentrum für Ökologie und Forstbau der Russischen Akademie der Wissenschaften erstellt wurde. Die Ergebnisse wurden am Donnerstag, den 13. Februar in der deutschen Botschaft in Moskau im Rahmen des wissenschaftlichen Vortragsprogramms der Botschaft vorgestellt.

Diese Studie bestätigt, dass es auf Grund des globalen Klimawandels im Durchschnitt in Russland wärmer und feuchter wird. Das führte zu der Meinung, dass die russische Landwirtschaft vom Klimawandel profitieren würde. Obwohl dies in einigen Teilen des Landes zutreffen mag, zeigt die neue Studie, dass es besonders in den Hauptanbaugebieten des Landes trockener werden dürfte, so dass wesentlich öfter Ernteeinbrüche zu erwarten sind. Insofern wäre die Ratifizierung des Kyoto-Protokolls durch Russland nicht nur ein positiver Beitrag zum Klimaschutz, sondern auch ein Beitrag zum Selbstschutz und zur Nahrungssicherung des Landes.

Nur 15 von insgesamt 89 administrativen Regionen der Russischen Föderation sind wichtige Agrarexportgebiete und versorgen den Rest des Landes mit Grundnahrungsmitteln; sie spielen entsprechend eine wichtige Rolle in der Nahrungsmittelsicherung des Landes. Ungefähr die Hälfte der gesamten russischen Agrarproduktion heutzutage stammt aus diesen Regionen. Die Klimaszenarien zeigen, dass es in diesen sowie anderen Regionen Russlands wärmer wird, aber sie zeigen ebenfalls, dass es speziell in diesen Hauptanbaugebieten trockener werden könnte. Einige der Klimaszenarien berechnen in diesen Gebieten eine Abnahme der durchschnittlichen Niederschlagsmenge von bis zu 50% zwischen dem durchschnittlichen Normalklima (1961 - 1990) und dem voraussichtlichen Klima im Jahr 2020. Dieses wärmere und trockenere Klima wird die Produktionsmöglichkeiten wichtiger Getreidesorten wie Weizen, Roggen, Kartoffeln, Mais und Gerste gefährden. In dieser neuen Studie haben Wissenschaftler berechnet, dass das Produktionspotential in den Hauptagraranbaugebieten um 5 - 20% bis zum Jahr 2020 abnehmen wird. Bis zum Jahr 2070 ist sogar ein Rückgang um 30 - 40% (bezogen auf die heutigen Durchschnitts-

werte) zu befürchten. Noch größere Rückgänge sind in einzelnen Regionen durchaus möglich. Unter heutigen Klimabedingungen kommt es in 10 Jahren durchschnittlich alle ein bis drei Jahre in den Hauptanbaugebieten zu erheblichen Ernteausfällen (abhängig von der Region). Unter veränderten Klimabedingungen muss für einige Gebiete bis 2020 mit einer Verdoppelung der Häufigkeit von schlechten Ernteergebnissen gerechnet werden und bis 2070 sogar mit einer Verdreifachung. Zusätzlich erhöht sich das Risiko, dass es in mehreren Hauptanbaugebieten gleichzeitig zu Ernteeinbrüchen kommt. Während heutzutage 58 Millionen Menschen in Gebieten leben, in denen regelmäßig Missernten auftreten, kommt die Studie zu dem Schluss, dass sich diese Zahl im Jahr 2020 auf 77 Millionen und im Jahr 2070 sogar auf 141 Millionen erhöhen wird.

Für die Wasserreserven des Landes sieht es nach den Ergebnissen der Studie ähnlich aus. Obwohl eine Niederschlagszunahme zu erhöhtem Abfluss in den Flüssen und einer höheren Grundwassererneuerung führen wird, und so den allgemeinen Druck auf die Wasserreserven vermindern dürfte, kommt es in den Hauptanbaugebieten zu einer Wasserverknappung. Im Südwesten des Landes ist Wasser sowieso schon knapp, und die Studie zeigt, dass es hier durch häufigere Niedrigwasserereignisse öfter zu Engpässen kommen wird. Auf der anderen Seite kann auch der erhöhte Wasserabfluss in anderen Gebieten zu einem erhöhten Risiko von Überschwemmungen führen.

Im Gegensatz zur herkömmlichen Einschätzung hat diese Studie gezeigt, dass Russland nicht nur nicht von einem wärmeren Klima profitiert sondern sogar erhebliche negative Konsequenzen erleiden könnte. Obgleich es durchaus Strategien gibt, sich an ein sich wandelndes Klima anzupassen, wäre es für Russland trotzdem wichtig, dabei mitzuwirken, dass die Treibhausgasemissionen weltweit gesenkt werden, um seine eigene Nahrungsmittel- und Wasserversorgung zu gewährleisten. Um das Kyoto Klimaprotokoll endlich umzusetzen, bedarf es nur noch der Ratifizierung eines großen Landes wie Russland, das hierbei den Ausschlag geben könnte.

Die Studie über die „Folgen des Klimawandels für die Nahrungsmittel- und Trinkwassersicherung in Russland“ unter Leitung von Prof. Dr. Joseph Alcamo, Direktor des wissenschaftlichen Zentrums für Umweltsystemforschung der Universität Kassel, und Prof. Dr. Genady Golubev, Professor an der Fakultät für Geografie der Universität Moskau und ehemaliger stellvertretender Direktor des Umweltprogramms der Vereinten Nationen UNEP, wurde Anfang Februar dieses Jahres abgeschlossen. An der Studie wirkten Wissenschaftler vom Wissenschaftlichen Zentrum für Umweltsystemforschung der Universität Kassel sowie von der Fakultät für Geografie der Universität Moskau und dem Zentrum für Ökologie und Forstbau der russischen Akademie der Wissenschaften mit. Die Studie wurde mit Mitteln der Max-Planck-Gesellschaft und der Humboldt Stiftung finanziert. Der Projektleiter Dr. Alcamo hatte 1998 den Max-Planck Forschungspreis gewonnen und mit den dotierten Mitteln dieses Preises das Projekt unterstützt.

Pressemitteilung der Universität Kassel, uh

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Mobile Hühner im Hühnermobil

UNIK und Bioland-Betrieb erarbeiteten Alternativen zur konventionellen Käfighaltung

Kassel. Nomen est omen: Den Hühnern in Freudenthal geht es gut. Das ganze Jahr verbringen sie auf dem freien Land, sie können nach Grünfutter und Kleintieren scharren und picken, zur Gefiederpflege staubbaden und nach schlechtem Wetter sonnenbaden. Ihr Stall, in dem sie ihre Legenester finden, der ihnen Futter, Schutz und Ruheplätze bietet, ist ein ausgeklappter und mobiler Wagen auf der Wiese.

Entwickelt wurde dieser Wagen, der 500 Hühnern Platz bietet, von Max Weiland, der zusammen mit seiner Frau Iris Weiland in Freudenthal bei Witzenhausen einen Bioland-Betrieb führt. Beide sind Absolventen des landwirtschaftlichen Studienganges der Universität Kassel. Zusammen mit Dr. Friedhelm Deerberg vom Fachgebiet „Ökologischer Landbau“ erarbeitete die Familie Weiland die Grundlage für ein mobiles Freilandhaltungsystem, das den Problemen der Freilandhaltung konstruktiv begegnet.

Durch ihr Scharren und ihre scharfen Exkremente können freilaufende Hühner in wenigen Wochen einen Auslauf in ein Schlammbad verwandeln. Daher muss der Zerstörung der Grasnarbe und dem Wurmbefall der Hühner durch Parasitenanreicherung im Auslauf, neben der Belastung der Luft und des Wassers durch übermäßigen Eintrag des Stickstoffes aus dem Hühnerdung, vorgebeugt werden.

Durch einen 14-tägigen Standortwechsel kann der mobile Hühnerstall diese punktuelle Überlastung und Überdüngung der Auslauffläche maßgeblich reduzieren. Auch aus diesem Grund wurde der Bioland-Betrieb Weiland in diesem Jahr mit dem Förderpreis Ökologischer Landbau des Bundeslandwirtschafts- und Verbraucherministeriums als einer von drei herausragenden Betrieben ausgezeichnet.

Die Familie Weiland habe ein Stall- und Freihaltungskonzept für Geflügel entwickelt und umgesetzt, das ökologisch wirtschaftenden und konventionellen Betrieben eine praktische, tiergerechte und umweltschonende Alternative für die Umstellung auf Freilandhaltung bietet, so die Laudatio anlässlich der Preisverleihung am 24. Januar in Berlin. Dem Wagen wurde unter dem Namen „Verfahrbarer Geflügelstall“ im Juli 2001 das Europäische Patent erteilt. Ab dem Spätherbst 2003 soll der mobile Hühnerstall dann auch in Serie gehen.

Da die neue Hennenhaltungsverordnung von März 2002 nicht nur ein Auslaufen der konventionellen Käfighaltung ab 2007 vorsieht, sondern ab 2012 auch die Haltung in

ausgestalteten Käfigen verbietet, sind die Haltungsbedingungen für Legehennen ein besonders drängendes Thema.

Zur Zeit befindet sich ein zweiter, vom Bonner Verbraucherministerium co-finanzierter Stall für 1000 Legehennen in der wissenschaftlich begleiteten Praxiseinführung. Im September 2002 haben die Hennen auf dem Betrieb Wagener bei Bad Wildungen den Wagen bezogen. Projektleiter ist Prof. Dr. Jürgen Heß, Fachgebiet Ökologische Landbaumethoden der Universität Kassel.

Grundlage der Arbeit an mobilen Haltungssystemen ist die Empfehlung von Prof. Dr. Detlef Fölsch (Fachgebiet Angewandte Nutztierethologie und artgemäße Tierhaltung), der in der Machbarkeitsstudie zum „Ausstieg aus der Käfighaltung“ von September 2001 für die Vergabe von Forschungsmitteln an Hochschulen zur Weiterentwicklung und Erprobung alternativer Haltungssysteme plädiert.

Pressemitteilung der Universität Kassel 32/03 - 12. März 2003, jk

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Notes to authors

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