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Factors Influencing Farmer-to-Farmer Transfer of an Improved Cowpea Variety in Kano State, Nigeria

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Abstract

Diffusion of improved technologies among small-scale farmers, especially where formal methods and market mechanisms are inefficient, can be enhanced through the participation of farmers. Unfortunately, formal methods of disseminating improved seed in most African countries have not taken advantage of the farmers' traditional transfer methods. This article deals with the role of farmer-to-farmer transfer and dissemination of an improved cowpea seed variety in Nigeria. Using household and farm level data from 133 respondents, the study adopts a logit model to investigate the determinants of the farmers' decision to transfer the new seed variety to other farmers. Area of improved cowpea cultivated, yield, market price of seed, use of pesticides and threshing quality were found to be significant variables affecting farmers' decision to transfer the improved cowpea variety.

Keywords: Farmer-to-farmer, seed, dissemination, cowpea, logit, Nigeria

1 Introduction

In most parts of Africa, the transfer of technology from agricultural research institutions to small-scale farmers is carried out largely by the public agricultural extension services and to a lesser extent by the private sector. With declining project support funds, budgetary constraints, and dwindling state budgets, the public extension services have become even less efficient in delivering agricultural information and in transferring new technologies. Also, with the rationalization of government extension departments, the extension to farmer ratios have widened, posing further constraints in the delivery of extension messages. The private sector has not responded adequately to fill up the gap in service provision to small-scale farmers created by the withdrawal of the state. This is due to the lack of sufficient trained personnel, unprofitability of providing services, the complex farming systems in which farmers operate and farmers inability to pay for the services (Kormawa *et al.*, 2001).

In the diffusion process, traditional dissemination methods have been found to be vital in technology transfer to farmers, especially for seed varieties, and improved livestock breeds that are usually introduced by the public or private sector (Cromwell, 1990). Within the process of participatory technology development attempts have been made to

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build on farmer-based knowledge (Ashby, 1990). These include the design of extension methods that would have greater impact on technology dissemination and transfer of new production inputs and methods. Recourse to the use of farmer-to-farmer communication is based on evidence (Grandstaff and Grandstaff, 1986) that even in areas were social organisation and infrastructure exists, farmers prefer their fellow farmers as their primary information source. Feder and Slade (1985), reveal that while farmers in India without access to formal extension service use farmer-to-farmer communication, most farmers also preferred fellow farmers as their major source of information were the Training and Visit extension system exists. Communication among farmers is an important factor in feeding local farmer experimentation; furthering exchange, encouraging adaptations to improved technologies and strengthening local capacity for self managed change. Fujisaka and Moock (1992) presented cases that illustrate how "farmer science" and "formal science" can be complementary in the development of more sustainable rice systems in the Philippines. Unfortunately, formal extension methods in most African countries have not taken advantage of the farmers' traditional technology transfer methods.

A growing amount of literature (Adesina and Bardu-Forson, 1995) exists on the influence of technology characteristics on the rate of adoption. Adesina and Zinnah (1990) show that technology characteristics determine their diffusion and a recent study by Negatu and Parikh (1999) also indicate that technology attributes and farmers perceptions influence the rate and speed of adoption. These studies have considered formal extension systems as an exogenous variable affecting the adoption of improved technologies. However, new insights can be gained as to whether farmer-to-farmer communication (i.e. the informal diffusion process) is also driven by economic considerations, sociological factors and technology-specific attributes and perceptions. As demand for improved seed and inputs increase, the need to strengthen this process and how it would lead to increasing adoption rates of improved technology becomes an important challenge to agricultural development.

This paper addresses the role of farmer-to-farmer transfer and dissemination of an improved cowpea variety IT90K-277-2 among farmers in Nigeria. Specifically, the objective of the paper is to determine the effect of economic, social and technological attributes and perceptions on farmers' decisions or willingness to transfer the improved cowpea variety to other farmers. This is necessary to inform researchers, extension planners, as well as agricultural NGOs on the importance of this method of technology transfer and dissemination.

1.1 Farmer-to-farmer diffusion of improved cowpea seed in Nigeria

Formal seed production and distribution systems in Nigeria are still not well established. Even the developing private seed sector tends to concentrate on maize and other cereals. In most cases, extension support and materials are specifically targeted only to these crops. This poses a major impediment to the adoption of improved cowpea seed among farming communities. In the technology development and adoption chain, gaps usually exist between technology developers, adopters, and even between technology leaders and

followers. Where a technology has to be adapted to farmers' circumstances and local conditions, there is narrower gap with the farmer-to-farmer technology transfer process. This is because farmers are involved in testing, watching and circulating information and therefore a greater chance of adoption is ensured. In the effort to bridge the gap between technology generation and adoption, the International Institute of Tropical Agriculture (IITA), Nigeria adopted a pro-active approach in some community-based seed production projects in West Africa (International Institute of Tropical Agriculture (IITA), 2000). One of the projects was concerned with providing support for cowpea seed production and the dissemination of improved cowpea seed among small-scale farmers in northern Nigeria.

In collaboration with the Institute for Agricultural Research (IAR), Zaria, and the Kano State Agricultural and Rural Development Authority (KNARDA), IITA began a cowpea seed production project in 1997, with initial funding from the German Agency for Technical Cooperation (GTZ). A demonstration approach was used to show the advantages of an improved cowpea variety - IT 90K-277-2. In the first year, a group of 50 farmers received 3 kg of breeder seed of the improved variety. The fields of these farmers served as demonstration plots to other farmers. An additional 51 farmers joined the group in the second year and 50 more in the third year. Each of these farmers received 3 kg of the pure seeds for planting. During these years (1997/1999), the number of farmers that grew and transferred the improved seed to other farmers, through seed sale or gift increased significantly. Table 1 shows how farmers disposed of their cowpea harvests in 1998 and 1999. Among the disposal methods, seed sale was the most important. The average quantity of cowpea sold as grains per farmer was 174 kg in 1998 representing 80 percent of total harvest. Quantity of seed sold per farmer decreased to about 163 kg in 1999 representing 70 percent of total harvest. Grain saved for household consumption or seed for next season planting ranged between 25 kg in 1998 and 31 kg in 1999, representing 11 and 15 percent of total harvest respectively. It is typical for small holders to save part of the harvest for subsequent planting season. Compared to seed sale, production for consumption purposes was less important. Farmers gave away seed to neighbours or relatives as gift. This is an important method of seed transfer among farmers in the study area. Average grain quantities given away increased slightly in 1999 from 21 kg to about 28 kg per farmer.

The number of farmers actually receiving the improved seed from farmers participating in the project is shown in Figure 1. The figure indicates that within 3 years about 4104 farmers received seed through participating farmers. In terms of cumulative number of adopters, the trend of recipient farmers in the years following the launching of the project follows the usual S-shaped curve over time (Rogers, 1995). Few farmers would be willing to try a new seed variety at the initial stage. As they learn more about the variety, more farmers will demand the variety. The declining number of recipients during the third year implies that recipient farmers may be saving seed from previous years. Also, the demand for the new seed by interested farmers within the immediate vicinity of project locations may have been satisfied. Studies elsewhere have shown that small-scale farmers generally prefer to use their own seed, as these are readily available

at planting time, no expense is incurred and the farmer is assured of the seed source and quality.

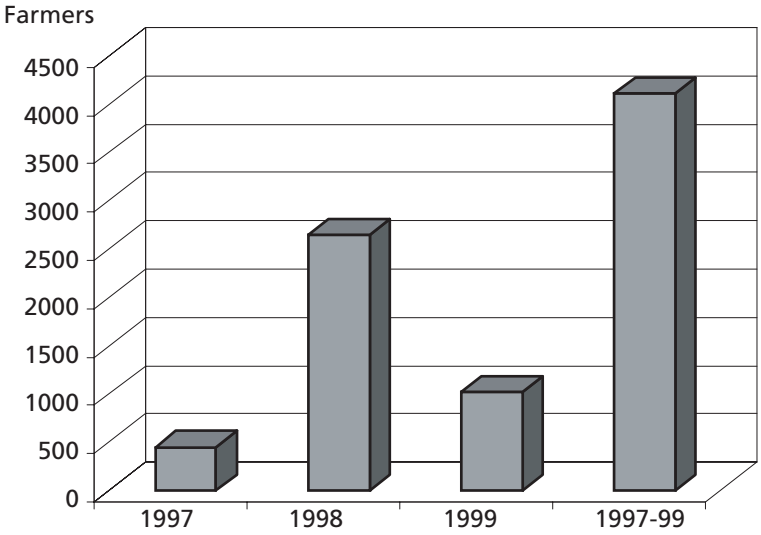
Table 1: Distribution of farmers Cowpea (IT90K-277-2) distribution in Nigeria

Year	*Household Food*		*Given as Gift*		*Sold as Seed*		*Total Disposal*
	Average (kg)	*%*	*Average (kg)*	*%*	*Average (kg)*	*%*	*(tonnes)*
1998	24.74	11.37	21.35	8.58	174.05	80.05	28,718
1999	31.31	15.83	28.09	14.21	162.88	69.96	28,918

N=133

Source: Cowpea farmers' survey 1999

Figure 1: Number of farmers receiving IT90K-277-2 seeds in northern Nigeria.



At the village level, when farmers have to buy seed, they prefer to buy from another farmer in the community. This provides major advantages for informal seed diffusion, especially for self-fertilizing crops, such as cowpea. This has been enhanced, as a result of better storage methods developed through research, enabling cowpea seed to be stored for longer periods without deterioration.

1.2 Theories of Agricultural Technology Diffusion and Adoption

Three theoretical models exist in the explanation of diffusion and adoption behaviour by farmers. These models are categorised into (a) the innovation-diffusion model (b) the economic constraints model and (c) the technology characteristics users' model (NEGATU and PARIKH, 1999). The innovation-diffusion or technology of transfer model arises from the work of ROGERS (1995). The model assumes that a technology is transferred from its source (the research institutes) to the end-users through agent medium (extension systems) and its diffusion in potential user communities depends primarily on the personal characteristics of the potential individual user. The important issue with respect to this model is that technology is appropriate for use provided that it is not hindered by the lack of effective formal and/or informal communication methods.

Emanating from the pioneering work of HAYAMI and RUTTAN (1971), the economic constraints model (or factor endowment model), assumes that the distribution of resource endowments among potential users in a country or region determines the pattern of technological adoption. The model further assumes that market prices reflect the relative factor scarcities in well functioning markets. The price ratio at the village level between modern inputs and marketable surplus must be low enough for their use to be profitable. Incentives to increase production and market surplus using improved inputs are reduced if remunerative output prices are not transmitted to farmers especially where physical barriers and transportation costs are high.

Complementary to the first two models, the relatively more recent technology characteristics users' model assumes that the characteristics of a technology, socio-economic and institutional contexts are the dominant determining factors in the adoption decision and diffusion process (SCOONES and THOMSON, 1994). In this model the perception of potential adopters as well as the characteristics of the technology are important determinants for adoption decisions and diffusion of the technology. This paper is interested in the institutionalisation of research and extension strategies that will facilitate the participation of farmers and other stakeholders in the development process. Therefore, the basic tenets of all three models are important for this paper since farmer-to-farmer communication is treated as an endogenous variable that can be influenced by economic and social/personal characteristics.

2 Methodology

2.1 Data source

Data on which the empirical model is based on were collected from 133 farm households drawn across 21 villages in eight Local Government Areas (LGAs) of Kano State. Improved cowpea seed had been previously introduced to all the villages under a cowpea seed production and dissemination project. The survey households were selected using a stratified random sampling technique. The sample comprised of project and non-project participating farming households. A pre-tested structured questionnaire was used to collect data from the sampled households. The survey was conducted from November to December 1999. The questionnaire was administered to the male household head.

Evaluation of farmers' transfer of the improved seed to others was posed as a dichotomous choice question. A household head was defined for this study as the participating farmer in the project. All respondents were male as it is not common for women to participate in agricultural activities beyond threshing and food processing, because of cultural reasons.

2.2 Conceptual framework

Farmer-to-farmer technology dissemination process can be viewed as an informal market where technology passes from supplying to recipient farmers (Grisley, 1994). The seed production plots on participating farmers' fields served as demonstration sites for others who were not directly involved in the project. This allowed farmers, researchers, and extension agents to evaluate the new seed variety for wider dissemination. Within the process, farmers adopt the technology and transfer to others. Non-participating farmers also visited the improved seed plots for evaluation purposes. Through these visits and interactions among participating and non-participating farmers, more non-project farmers became interested in acquiring the seed for planting in subsequent seasons. The new cowpea seed variety is being popularised among farmers through this farmer-to-farmer transfer approach. Given that the role of the extension service in the transfer of seed is very limited and that the supply of technology is fixed, further investigation of the process became of interest. Seed technology, unlike other forms of innovation (especially information), is tangible and usually in fixed quantities. Therefore, we hypothesize that transfer to others will depend on farmer specific characteristics, market price, total cultivated area with the improved seed, as well as farmer perception on the superiority of the variety. Apart from price factors, farmers derive utility from transferring seeds to relatives or friend as gifts. Also, because small-scale farmers usually store part of the harvest for household consumption, perceptions on consumption qualities will also affect transfer.

2.3 Modelling farmer to farmer seed transfer

In assessing the factors that determine farmers' decisions to transfer, we require a model that deals with the dichotomous dependent variable "transferred seed or not transferred." This behavioural dependent variable can be used to examine the relationship with the independent variables. Such models cannot be estimated by either multiple regression or the ordinary least square (OLS) techniques. Multiple regression technique results in invalid parameter estimates and wrong magnitude of the effects of the independent variables on the dependent variables. In the case of OLS, assumptions that the variances of the error terms are constant and not correlated with the level of independent variables are violated. Consequently, four commonly used approaches to estimate such models are: the linear probability model (LPM), logit model, probit model, and the Tobit model (Gujarati, 1995). Like the OLS technique, the LPM is also plagued by several problems and is not generally recommended. The LPM provides predicted values that may fall outside the 0-1 intervals, thus violating the assumption of probability. The

remaining model types give maximum likelihood estimators and overcome most of the shortcomings of linear probability model, by providing consistent and efficient estimates.

Among the three other techniques proposed, we opted for the logit model framework as described by MADDALA (1983) and GUJARATI (1995). This model has been applied in a similar study (GRISLEY, 1994) and has been found to be efficient in explaining such dichotomous decision variables. In formulating the model, we assumed that P_i is the observed response of farmer i, (i.e. $P_i = 1$ for transferring, otherwise $P_i = 0$), the decision to transfer by an i^{th} farmer depends on X_i, which is a vector of factors representing the farmer-specific, economic, social, cowpea attribute, and farmers' perceptions. The disturbance term is represented by (ξ) and assumed to have a mean equal to zero. Conceptually, the decision model can be stated as follows (equation 1):

$$\ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \sum_{j=1}^{n} \beta_j X_{ji} + \xi \tag{1}$$

The empirical model specifying the transfer of the improved seed is implicitly stated in equation 2. The dependent variable is represented by the natural log of the probability to transfer seed P_i to another farmer or the probability not to transfer seed $(1 - P_i)$. The error term is assumed to be independently distributed over the sample and accounts for the unobservable variables and characteristics of the surveyed households.

$$\begin{aligned} \ln\left(\frac{P_i}{1-P_i}\right) &= (\beta_0, \beta_1 St, \beta_2 Fl, \beta_3 Mr, \beta_4 Mk, \beta_5 Ar, \beta_6 Yl, \beta_7 Ct, \beta_8 Sr, \beta_9 Ap, \\ &\quad \beta_{10} Tp, \beta_{11} Tq, \beta_{12} Bq, \xi) \end{aligned} \tag{2}$$

Explanation of these variables is provided in Table 2. The independent variables are categorised into four, namely: sociological, economic, complementary or substitute inputs and perception variables. The sociological variables include membership of social organisations (Mr), the use of family labour in cowpea production (Fl), and status of farmer (St). The economic variables included in the model are market price (Mk) of improved cowpea, yield of improved cowpea (Yl), area cultivated of improved cowpea (Ar), number of cattle owned by farmer (Ct), number of small ruminants owned by farmer (Sr) and transportation costs (Tp). The complementary inputs variable includes use of agrochemicals (Ap) in cowpea production while the perception variables include threshing quality (Tq) and cooking (Bq) quality of improved cowpea variety as perceived by the farmers in the study area. In formulating the model to include the above variables, various working hypotheses were taken into consideration. These are discussed in the following paragraphs.

Farmers usually belong to various types of social organisation and also form part of various networks. Membership in social organisations (Mr) implies that farmers meet regularly and allow discussions on farm issues. Therefore membership in social organisations may lead to sharing of information on agricultural inputs; thus (Mr) is expected to positively affect farmers' decision to transfer improved cowpea seeds. Use of family labour (Fl) in cowpea production is also postulated to have a positive effect on the

Table 2: Description and means of variables in the model

Variable	*Unit*	*Description*	*Mean*	*SD*
Sociological				
St	Binary	Farmer social status, 1 if titled,0 otherwise	0.2879	0.4545
Mr	Binary	Member of organisation, yes=1; otherwise 0	0.4384	0.4385
Fl	Number	Household members who work on the farm	3.030	3.092
Economic				
Mk	Number	Cowpea market price (₦/100kg)	8259.71	13189.98
Ar	Number	Total cowpea area harvested (ha)	0.4823	0.5292
Yl	Number	Yield per hectare of IT90K-277-2 in kg	399.06	693.61
Tp	Number	Transport cost to market (₦)	4.150	2.10
Ct	Number	Cattle owned by household head	6.815	10.52
Sr	Number	Small ruminants owned by household head	10.050	9.44
Complementary				
Ap	Binary	Applied pesticide, yes = 1; otherwise 0	0.6667	0.4732
Perception				
Tq	Binary	Threshing, 1 = better than local, 0 otherwise	0.8400	0.3681
Bq	Binary	Boiling, 1 = better than local, 0 otherwise	0.8487	0.3598
N=133				

dissemination of improved cowpea to other farmers. Status of farmer (St) is defined as respondents who have farming as their primary occupation but are also considered men of status in the community (e.g. "Sarkin Norma", master farmer). This variable is expected to have a positive influence on farmers' decision to transfer seed.

Unlike Grisley (1994), who used total crop area as a measure of farm size, an indication of homestead wealth and as a proxy of social status and influence within the community, we use the same variable as an economic variable in this study. Area cultivated of the improved cowpea seed is expected to have a positive sign, as farmers are likely to increase the area cultivated (through leasing or sharecropping) if they like the cowpea variety. Traditionally, leasing or sharecropping for cultivation requires payment in kind such as giving out a certain proportion of output to the landlord. This variable (Ar) is expected to have a positive effect on farmers' decisions to give out improved cowpea seeds to other farmers. Yield from plots planted with improved cowpea seed will also positively influence farmers' propensity to transfer seed to others. The comparative yield advantage of improved (Yl) over local cowpea seed was postulated to affect farmers'

decision to transfer seeds positively. This is based on the assumption that the better the yield of the improved seed over the local variety, the higher the demand for the seed from other farmers in the community. Cowpea is considered a commercial crop in the study area while crops like millet are produced for home consumption. It is therefore postulated that the demand for improved cowpea seeds will increase because of its high value on the market. A positive sign is expected for the variable (Mk). Hence the higher the market prices of the improved cowpea in the market the greater the likelihood of the farmer to disseminate the seeds to other farmers. In contrast, transportation costs (Tp) is postulated to have a negative effect on farmers' decisions to disseminate improved cowpea seeds to fellow farmers. Cattle and small ruminants are stores of wealth in African agriculture. It is therefore postulated that the higher the number of cattle and small ruminants owned the wealthier the farmer and the greater the likelihood of transferring improved cowpea seeds to other farmers. Hence it is expected that the coefficients of the variables for Ct and Sr will have a positive effect on farmers' decision to transfer improved cowpea seeds.

An important source of risk in cowpea production is damage from pests. This is of particular concern to farmers especially because cowpea is a commercially oriented crop with informal quality standards in the market. Pest damage directly affects the proportion of crop marketed and thus a farmers' profit. Hence a farmer's pest management decision is directed towards reducing damage from pest through the use of pesticides. Farmers who use pesticides to produce improved cowpea seeds may derive higher yield benefits but may not have the propensity to share this new innovation with other farmers, friends or relatives because of additional expenditure on pesticides. The coefficient of the variable Ap is postulated to have a negative influence on farmers' decision to transfer improved cowpea seeds to other farmers.

Farmers are likely to spread the news of a new crop variety to other farmers if they perceive positive post harvest qualities in the variety. The perception variables included in the model are threshing quality (Tq) and cooking quality (Bq). Following Adesina and Zinnah (1990) we also postulate that ease of threshing and cooking are positively related to farmers' decisions to give away improved cowpea seeds to their fellow farmers.

3 Results and Discussions

The maximum likelihood algorithm of the $LIMDEP$ package was used to estimate the empirical model. Estimates of the coefficients and significant levels are presented in Table 3. The chi-square goodness-of-fit test statistics of the model show that the model fits the data with significance at 1% level. This shows that the independent variables are relevant in explaining the farmers' decision to transfer the improved seed variety. T test of the parameter estimates indicates that the decision to transfer seed is mainly influenced by six variables.

The coefficient of the sociological variable (Fl) possesses the expected sign. The use of family labour (Fl) in farm production may likely influence farmer-to-farmer dissemination of improved cowpea variety positively. This observation was however not statistically significant. The coefficient of the variable measuring farmer status (St) was found to

Table 3: Parameter estimates of the logit model of the decision of a small-scale farmer to transfer improved cowpea seeds to other farmers

Variable	*Parameter Estimate*	*Standard Error*	*T values*
St	-0.2055	0.2829E-03	-0.727
Mr	-0.1189E-03	0.1908E-03	0.623
Fl	0.1917E-02	0.1048E-01	0.183
Mk	0.2152E-04	0.2516E-03	4.405*
Ar	0.1233E-02	0.8237E-04	4.902*
Yl	-0.2954E-03	0.1966E-03	-3.586**
Tp	-0.8216E-04	0.8066E-04	-1.242
Ct	0.6576E-04	0.6907E-04	1.334
Sr	0.2027E-03	0.9614E-04	1.669
Ap	-0.6805E-03	0.1966E-03	-3.462**
Tq	0.5495E-03	0.1581E-03	3.475**
Bq	0.2178E-03	0.1088E-03	2.002
INTERCEPT	0.8796	0.7325E-01	12.008*

Log likelihood function = -21.899; Chi squared = 96.19;
* Significant at 1%; ** Significant at 5%; n = 133

influence farmers' decisions negatively but not significantly. This indicates that, farmers with social status in the village are not likely to enhance farmer-to-farmer diffusion of improved cowpea seeds at the farm level. Similarly, the coefficient of the sociological variable Mr does not agree with *a priori* expectations. Even though the variable is not significant it indicates that farmers who belong to social organisations are not likely to share seeds amongst themselves. It is likely that they can share information on agricultural production issues but not necessarily disseminate seeds. Also it is possible that participating farmers belonging to the same or different organisations in the study area all had the improved breeder seeds with the introduction of the project.

The coefficient of total cowpea area cultivated (Ar) was positive and significant at 1% level. This implies that farmers with relatively larger cowpea farms will be more willing to transfer seed. Grisley (1994) obtained a similar result from a study among small-scale bean farmers in Uganda. In addition, farm size has been documented in various studies to be an important factor in technology adoption and dissemination (Feder *et al.*, 1985). This finding supports other studies and suggests that farm size can be an indicator of the farmers' decision to transfer new cowpea seed to other farmers. Total improved cowpea area harvested is therefore consistent with *a priori* expectations.

The coefficient for the economic variable representing seed market price, (Mk) is significant at 1% level and has the expected sign. The null hypothesis, that market price was irrelevant to the farmers' decision to transfer seed, is rejected. This implies that seed price is relevant and that farmers become more willing to transfer seed to others as they receive higher market prices for seed. A profitable market price is therefore likely to enhance farmer-to-farmer transfer of improved technologies at the village level.

The sign of the coefficient Yl behaved contrary to *a priori* expectations. The value of the variable indicates that the higher the yield obtained, the less the likelihood of farmers to transfer the improved variety to other farmers. The coefficient of this variable was found to be significant at 5%. Evidence (table 1) already suggests that farmers sell most of their output but higher yields do not necessarily mean that farmers will exceed their existing seed transferring capacity to other farmers. They are likely to maintain the same level of seed transfer due to greater productivity of the new improved seed variety. The signs of the coefficients for the other economic variables namely, Ct and Sr, were consistent with *a priori* expectations. The coefficient of the variable for small ruminants was significant at 10% probability level. This was not the case for the coefficient of the variable Ct. Hence the more livestock owned by a farmer, the more likely for him to transfer improved cowpea seeds to other farmers. Since farmers use livestock as a store of wealth, this observation suggests that wealthier farmers have a higher propensity to disseminate improved seed varieties. Use of complementary inputs like pesticide is postulated to discourage farmer-to-farmer dissemination of improved seeds. The coefficient of this variable agrees with *a priori* expectations and is found to be significant at 1%. Hence the extra expenditure required to purchase pesticides for production of improved cowpea may limit farmer-to-farmer dissemination of seeds at the farm level.

Farmers were asked to compare the threshing quality of the improved cowpea with that of local varieties in the study area. As expected, the coefficient of the variable (Tq) has the *a priori* positive sign and was found to be significant at 1%. Similarly, farmers' perception of the cooking quality (Bq) of the improved cowpea was consistent with *a priori* expectations even though it was not significant. Hence, farmers' perceptions about the threshing and cooking quality are important factors in explaining their willingness to transfer the improved cowpea variety to other farmers.

Individual farmer specific characteristics such as age, gender, and education variables that may affect the decision of a farmer to transfer seed were not included in the model. Gender was not included because all household heads were male. This is very typical in a mainly Moslem part of the country. Also, frequency of extension visit was not included because farmers participating in the seed production project had the same exposure to both extension and research staff involved in the project.

4 Summary and conclusion

The decision of farmers to transfer improved seed to others was influenced by the market prices of cowpea showing that market forces are important in explaining the rate of adoption of farm innovations. In order to enhance the production and dissemination of

improved seed by small-scale farmers, production and distribution channels must remain profitable. Programs aimed at developing small-scale farmer seed production should ensure that cooperating farmers regard the project as a commercial enterprise, rather than a development project. Farmers' wealth status as indicated by number of livestock owned and area of land cultivated of the improved cowpea variety is important for farmer-to-farmer seed diffusion.

Farmers' perceptions on the post harvest qualities of the improved cowpea variety namely threshing quality and boiling quality are important in seed diffusion process. Thus, programs promoting farmer-to-farmer seed diffusion should ensure that crop varieties disseminated have acceptable post harvest technology attributes.

The informal approach to seed dissemination, can also complement formal seed exchange mechanisms, but would require to be strengthened for the rapid transfer of improved seed among farmers. For research institutions such as IITA that cooperate with farmers in various stages of improved seed development, a further step to increase impact is to develop mechanisms to strengthen the informal seed production and dissemination mechanisms. Such strategies could be developed in partnership with the existing institution, particularly farmers' organizations. Research or extension service providers could provide farmers' organizations with high quality seeds for multiplication and organize them into local seed producers and dealers. However, although, farmers may be the ideal partners in promoting diffusion of improved seeds, their circumstances (sociological, economic and perception factors) plays an important role in the supply of seed to other farmers.

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References

Adesina, A. A. and Bardu-Forson, J.; Farmers' perception and adoption of new agricultural technology: evidence from analysis in Burkina Faso and Guinea, West Africa; *Agric Econ*; 13(1); 1995.

Adesina, A. A. and Zinnah, M. M.; Technology characteristics, farmer perceptions and adoptions decisions: a tobit model application in Sierra Leone; *Agric Econ*; 9(4); 1990.

Ashby, J.; Evaluating technology with farmers; CIAT Cali; 1990.

Cromwell, E.; Seed diffusion mechanisms in small farmer communities; Network Paper 21. Agricultural Administration, Overseas Development Institute, London; 1990.

Feder, G., Just, R. E. and Zilberman, D.; Adoption of agricultural innovations in developing countries: a survey; *Economic Development and Cultural Change*; 33(2); 1985.

Feder, G. and Slade, R.; The role of public policy in the diffusion of improved agricultural technology; *American Journal of Agricultural Economics*; 67(2); 1985.

Fujisaka, S. and Moock, J. L.; Farmer knowledge and sustainability in rice farming systems: blending science and indigenous innovation; in: *Diversity, farmer knowledge,*

and sustainability, edited by MOOCK, J. L. and RHOADES, R. E.; Cornell University Press, Ithaca, New York, USA; 1992.

GRANDSTAFF, T. B. and GRANDSTAFF, S. W.; Choice of rice technology: a farmer perspective; in: *Community management: Asian experience and perspectives*, edited by KORTEN, D. C.; Kumarian West Hartford; 1986.

GRISLEY, W.; Farmer-to-Farmer transfer of new crop varieties: an empirical analysis of small farms in Uganda; *Agric Econ*; 11(1); 1994.

GUJARATI, D. N.; *Basic econometrics, 3^{rd} edition*; McGraw-Hill, Singapore; 1995.

HAYAMI, Y. and RUTTAN, V. W.; *Agricultural development: an international perspective*; Johns Hopkins University Press, Baltimore; 1971.

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE (IITA); Annual Report 1999; IITA, Ibadan, Nigeria; 2000.

KORMAWA, P., AWOYEMI, T. and AKINGBILE, A.; Farm Management in the Provision of Extension Services in Nigeria: An assessment and a strategy for improvement; Report submitted to the FAO, UN; 2001.

MADDALA, G. S.; *Limited dependent and quantitative variables in econometrics*; Cambridge University Press; 1983.

NEGATU, W. and PARIKH, A.; The impact of perception and other factors on the adoption of agricultural technology in the Moret and Jiru Woreda (district) of Ethiopia; *Agric Econ*; 21(2); 1999.

ROGERS, E. M.; *Diffussion of innovations, 4^{th} Edition*; The Free Press, New York; 1995.

SCOONES, I. and THOMSON, J.; Knowledge power and agriculture - towards a theoretical understanding; in: *Beyond farmer first: rural peoples knowledge and extension practice*, edited by SCOONES, I. and THOMSON, J.; Intermediate Technology Publications, London; 1994.

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Phosphorus Uptake and Balance in a Soyabean-Maize Rotation in the Moist Savanna of West Africa

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Abstract

This study investigated the effect of maturity class on phosphorus (P) balance in a soyabean-maize rotation in the West African moist savanna. Four soyabean varieties of different maturity classes were grown with or without P fertilizer followed by a maize crop. Soyabean stover P content averaged 1.77 kg ha^{-1} compared with 5.13 kg ha^{-1} in the grain. The late soyabean variety TGx1670-1F accumulated a significantly higher P in the grain (6.56 kg ha^{-1}), and stover (2.57 kg ha^{-1}) than the others. While P harvest index averaged 79%, P application increased grain P by 63-81% and stover P by 100% or more. When either soyabean grain or grain+stover was exported, P balance was negative and was not statistically different for varieties when no P was applied. At 30 or 60 kg P ha^{-1}, P balance was negative but significantly lower in TGx1670-1F compared with other varieties. Increasing P rate applied to soyabean significantly ($p < 0.01$) increased maize grain P by 35-66% in the second year. When P was exported only in soyabean grain, cumulative P balances after maize grain harvest (with no P or 30 kg ha^{-1} applied previous year) were not significantly different for previous soyabean crops. At 60 kg ha^{-1}, however, P balance in previous TGx1670-1F plot was significantly lower than for other varieties. A further export of soyabean stover reduced P balance. Significant residual P effect was observed emphasizing the need to focus P fertilizer application in the cropping system rather than on the single crop. Also with more P in soyabean grain, a reduction in the extent of P depletion will be achieved by returning soyabean stover to the field after threshing.

Keywords: phosphorus balance, soyabean, moist savanna, maize, rotation

1 Introduction

The moist savanna make up to 80% of the land area in West Africa. With a precipitation/evaporation ratio of between 0.40 and 0.10 (Isichei and Akobundu, 1995), this ecological zone is well suited to annual crops of medium duration such as groundnut,

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maize and soyabean (JAGTAP, 1995). Low levels of soil available phosphorus (P) are, however, common in this ecological zone and this has been attributed to the low levels of clay and organic matter (MANU *et al.*, 1991). Under low soil P status, P fertilizer application to legume and its management are of importance in attaining high yields. Not the entire nutrient element applied in fertilizers, however, is absorbed and incorporated into crop plant tissues. Phosphorus for instance, is immobile in the soil. Only 10-30% of the P applied in fertilizers in tropical areas is recovered by crop plants (BALIGAR and BENNETT, 1986). From their work on cowpea, ANKOMAH *et al.* (1995) reported that the crop was able to recover 8 to 9.4% of the P applied as triple superphosphate. Much of the unabsorbed P remains in soil as fertilizer reaction products. These fertilizer reaction products are only slowly available to the crop and carry some residual value to the succeeding crop in the cropping sequence (FIXEN and LUDWICK, 1982).

Where cereals follow grain legumes in rotation, PANDEY and MCINTTOSH (1990) have hypothesized that adequate P fertilization of the legume may eliminate or considerably reduce the amount of P fertilizer needed for the cereal. A fertilization practice in which P is first applied to the legume component in a legume-cereal rotation is premised on the importance of P in biological nitrogen fixation (BNF). When BNF is maximized by non-limiting P supply, a greater amount of residual N is available to the subsequent cereal crop. In their work on pigeon pea, AE *et al.* (1991) reported that the crop can convert $Fe-P$ into available form of P, thus making P more available to subsequent crop. The farmer can, therefore, appropriate the benefits of residual P on subsequent cereal crop in a legume-cereal rotation system. As crops are harvested, however, the nutrient elements accumulated in the harvested biomass are consequently removed from the system. According to KUMARI *et al.* (1992) available P under soyabean showed a positive balance where no P fertilizer was added, and negative balance where P was added. They attributed this to the greater amounts of P removed in the higher yields obtained with fertilizer treatments. Such exports lead to reduction in total nutrient balance (STOORVOGEL and SMALING, 1990; BATIONO and MOKWUNYE, 1991). In the moist savanna of West Africa, the resulting nutrient balances in crop fields are generally negative because crop nutrients are derived from the already low soil stock which is usually not supplemented with inorganic fertilizer because of high costs and availability. As this negative nutrient balance becomes recurrent, soils of low nutrient status are further depleted (RHODES *et al.*, 1996). There is, therefore, the need for P management practices that will optimize yield and economic returns as well as nutrient and water use efficiency (DAVIS *et al.*, 1994). In order to establish the appropriate P fertilizer practice, this study was carried out to determine the amount of P loss in a soyabean-maize rotation, and consequently determine the P balance in the system.

2 Materials and Methods

Field studies were carried out during the growing seasons of 1996 and 1997 at Mokwa (9°18'N, 5°04'E), Fashola (7°56'N 3°45'E), Gidan Waya (9°28'N, 8°22'E) and Kasuwan Magani (10°24'N, 7°42'E) in the moist savanna ecological zone of Nigeria where the length of growing period is 151-270 days. Varying amounts of rainfall are, therefore,

received across this zone. Distribution and average amount of rainfall at experimental sites in the 1996 and 1997 cropping seasons are presented in Table 1. The site at Mokwa had been variously planted to cowpea and maize until 1995. Maize, sorghum and groundnut were planted at Kasuwan Magani until 1995. At Gidan Waya, the land was planted to soyabean in 1995 after being fallowed for over 20 years. The site at Fashola had been fallowed for over 20 years before clearing in 1996. Although information on previous soil fertilization practices for the sites were not available, the available soil P determined using Bray II according to the procedures outlined by OKALEBO *et al.* (1993), was 16.2 mg kg^{-1} at Mokwa while the values at the other sites were less than 7 mg kg^{-1}. Other chemical and physical characteristics of the soils at the time of sowing in 1996 are shown in Table 2.

Table 1: Distribution and average amount of rainfall at experimental sites in the 1996 and 1997 cropping seasons

Month	*Amount of Rainfall (mm)*			
	Mokwa	*Fashola*	*Gidan Waya*	*Kasuwan Magani*
May	211	147	48	172
June	242	256	241	258
July	126	102	368	266
August	185	120	363	419
September	80	215	142	319
October	87	99	100	90
Total Rainfall	931	939	1262	1524

Table 2: 1996 pre-planting soil chemical and physical properties at the experimental sites

Properties	*Site*			
	Mokwa	*Fashola*	*Gidan Waya*	*Kasuwan Magani*
pH (1:1 soil/H_2O)	6.1	6.1	4.9	5.6
Organic Matter (g kg^{-1})	0.88	1.02	1.50	1.30
Total N (g kg^{-1})	0.60	0.69	1.13	0.78
Bray-II P (mg kg^{-1})	16.2	5.2	6.2	5.7
Sand (g kg^{-1})	770	860	650	590
Silt (g kg^{-1})	190	110	210	260
Clay (g kg^{-1})	40	30	140	150
Textural Class	Loamy Sand	Loamy Sand	Sandy Loam	Sandy Loam

Four soyabean varieties: TGx1670-1F and TGx923-2E, maturing in 115-120 days; TGx536-02D (Medium), maturing in 100 days; and TGx1485-1D (Early), maturing in 95 days were sown at all sites in 1996. The soyabean varieties as main plot treatments received P (sub-plot treatment) which was applied as triple superphosphate (20% P) at the rates of 0, 30 and 60 kg P ha^{-1}. Treatments were assigned in a split-plot arrangement in a randomised complete block with three replications. P was applied and mixed with soil in furrows made at the top of ridges to the depth of 6-8 cm. The ridges were 75 cm apart and soyabean seeds were drilled along the ridges after the application of triple superphosphate. Soyabean seedlings were thinned to 8 cm within row spacing three weeks after planting. Late soyabean varieties were sown three weeks before the early and medium varieties at all sites. In 1997, ridges in each plot were re-made and the maize variety, TZEComp4C2, was sown in all plots at all sites.

At harvest in 1996, soyabean plants within 2 m length of three central rows were cut at the base. Pods were separated from each aboveground harvest, dried and shelled for grain. Soyabean litter was collected at grain harvest using 0.5 x 0.5 m quadrat within each sub-plot, air-dried and cleaned of soil. In 1997, maize grain yield was determined by harvesting the 2 m length of the three central rows in each plot. The soyabean stover (which included haulm and the pod wall obtained after shelling), grain, litter, and maize grain were oven-dried for 48 h and milled to pass through 1 mm sieve. The P contents were then determined by digestion with H_2SO_4 and subsequently colorimetry (Okalebo *et al.*, 1993). The amount of P left in the field after grain harvest depends on the total amount of P accumulated. Soyabean phosphorus harvest index (PHI) was determined as a ratio of grain P to total plant P in standing biomass at harvest. P balance after soyabean crop was determined for when: (i) only soyabean grain was exported; and (ii) soyabean grain with stover was exported. In both cases, the amount of P exported in the biomass was subtracted from the amount of P applied in fertilizer. P balance after maize grain harvest was determined by subtracting the P in maize grain from the previous P balance after the soyabean crop when either soyabean grain or grain with stover is exported. Data were analyzed using the Generalized Linear Model Procedures of the Statistical Analysis System Institute Inc. (1992).

3 Results and discussion

3.1 Soyabean Grain P content

Grain P content at harvest was significantly different for soyabean varieties at $p < 0.01$. Table 3 shows that soyabean grain P content increased with duration. The late variety TGx1670-1F accumulated a significantly larger amount of P in the grain (6.56 kg P ha^{-1}), this was at least 48% higher compared to the other varieties. The amount of P accumulated in the grain of the other late variety TGx923-2E was, however, not significantly different from that in Early and Medium. The interaction of site by P rate had a significant effect on soyabean grain P at $p < 0.01$. Increasing P rate significantly increased grain P in soyabean at all sites except Mokwa where the initial available soil P was 16.2 mg kg^{-1}. Enwezor *et al.* (1989) have classified available P status as low when less than 15 mg kg^{-1}, medium if within the range of 15-25 mg kg^{-1}, and

high if greater than 25 mg kg^{-1}. They have noted that while low availability is below critical level, at medium availability is above critical level and response to fertilization is expected. Response is unlikely and fertilization may not be necessary at high soil available P level. Grain P in this study showed no significant response to P application at Mokwa where soil available P was 16.2 mg kg^{-1} and may, therefore, be classified as high. WEBB *et al.* (1992) have also reported that increases in soyabean grain yield (from which grain P content is derived) due to P fertilizer application are small or non-existent when soil test P is high. At other sites available soil P was <7 mg kg^{-1} and the responses to an initial 30 kg P ha^{-1} application was observed to have increased grain P by 94-130%. A second increment in P application of 30 kg ha^{-1} at these sites was observed to have significantly increased grain P content (by about 83%) only at Gidan Waya. The soil at this site was strongly acidic with pH of 4.9 (1:1 soil/H_2O). This must have given rise to a greater degree of P fixation compared to other sites. As the fixation sites are saturated, the effect of additional P applied in fertilizer became apparent. The differences observed in grain P among the sites were significant ($p < 0.01$). Although grain P was not affected by P application at Mokwa, the amount of P (6.24 kg P ha^{-1}) accumulated in soyabean grain at this site was higher than at other sites by at least 54% (Table 3). Averaged over sites and varieties, soyabean grain P was significantly ($p < 0.01$) increased by 62% when 30 kg P ha^{-1} were applied. A second 30 kg P ha^{-1} application did not result in a significant increase in the amount of P accumulated in soyabean grain. These results show that above 30 kg P ha^{-1}, no significant response was observed in soyabean. When soil test P is low, therefore, applying P to soyabean at the rate of 30 kg ha^{-1} may be enough to build up soil available P to a sufficiency level.

Soyabean grain P was also significantly ($p < 0.01$) affected by the interaction of variety by P rate. Increasing P rate significantly increased grain P content in the varieties (Table 3). Without P amendment, the amount of P accumulated in soyabean grain was not different for all the varieties. This shows that the soyabean varieties used in this study were not different in their abilities to utilize soil P at low available P levels. The larger response to P application was observed in the late varieties that also accumulated significantly more P in the grain compared to the Early and Medium. With an initial application of 30 kg P ha^{-1}, grain P was higher by 38-40% in Early and Medium, and 79-95% in late varieties. In only one late variety TGx1670-1F the additional 64% increase in grain P resulting from a second 30 kg P ha^{-1} increment was significant. Apart from varietal characteristics, nutrient accumulation is a function of growth duration, hence, the larger amount of grain P in the late varieties.

3.2 Soyabean stover P content

The interaction of site by P rate was significant on soyabean stover P content at $p < 0.01$. At all sites, more P was accumulated in soyabean stover with increasing P rate (Table 3). Significantly more P was accumulated in soyabean stover at Mokwa compared to other sites and while least amount of P was accumulated in stover at Gidan Waya. More P was accumulated in soyabean grain than stover at each P level and at each

Table 3: Effects of site, variety, and phosphorus on soyabean grain and stover P content, and phosphorus harvest index (PHI).

	P rate (kg P ha^{-1})			*Mean*
	0	*30*	*60*	
	Grain P (kg ha^{-1})			
Site				
Mokwa	6.32	6.70	5.69	6.24
Fashola	2.43	4.72	4.97	4.04
Gidan Waya	2.14	4.92	6.70	4.58
Kasuwan Magani	3.12	6.41	7.92	5.82
Variety				
TGx1485-1D	3.43	4.73	5.10	5.10
TGx536-02D	3.72	5. 19	5.18	5.18
TGx923-2E	3.30	5.91	5.79	5.79
TGx1670-1F	3.55	6.92	9.21	9.21
Mean	3.50	5.68	6.32	
	Stover P (kg ha^{-1})			
Mokwa	2.84	4.75	6.11	4.57
Fashola	0.26	1.10	1.38	0.91
Gidan Waya	0.22	0.77	0.83	0.61
Kasuwan Magani	0.49	0.94	1.52	1.02
Mean	0.95	1.89	2.46	
	PHI (%)			
Mokwa	71	59	49	59
Fashola	90	81	79	83
Gidan Waya	89	86	88	88
Kasuwan Magani	85	87	81	84
Mean	84	78	74	

Standard Error (grain P): site = 0.294, variety = 0.293, P rate = 0.261, site × P rate = 0.520, variety × P rate = 0.520

Standard Error (stover P): site = 0.160, P rate = 0.135, site × P rate = 0.269

Standard Error (PHI): site = 0.012, P rate = 0.010, site × P rate = 0.020

site. Although increasing P rate had no significant effect on grain P at Mokwa, results show that it significantly increased stover P at this site (Table 3). Averaged over sites and varieties, the application of 30 kg P ha^{-1} significantly increased stover P content twofold and a second 30 kg P ha^{-1} application resulted in a further 60% increase. Stover P content was significantly ($p < 0.01$) affected by soyabean variety. Evidently due to duration, significantly more P was accumulated in the stover of late varieties with the larger amount in TGx1670-1F (Table 3). Stover P contents in Early and Medium were not different. Stover P content was not significantly different in the varieties when no P was applied.

3.3 Soyabean litter P content

The effect of site was significant ($p < 0.01$) on soyabean litter P content. More P (4.11 kg P ha^{-1}) was accumulated in soyabean litter at Mokwa and this was 72-83% higher than at other sites (Table 4). The lower litter P contents observed at Fashola, Gidan Waya and Kasuwan Magani are attributable to the low initial available P content which was =6.2 mg kg^{-1} at any of this sites. Chiezey *et al.* (1992), have similarly reported varying responses to P due to soil P status. Soyabean variety significantly affected litter P content at $p < 0.05$. Table 4 shows that the late variety, TGx1670-1F, accumulated at least 76% more P in the litter although this was not significantly different from litter P contents of the other late variety (TGx923-2E), and the Medium. The application of P to soyabean significantly ($p < 0.01$) increased litter P, and compared to no P amendment 30 kg P ha^{-1} increased litter P by 95% while a second 30 kg P ha^{-1} increment gave no significant increase (Table 4). Significant site by P rate, and variety by P rate interactions were not observed on litter P.

3.4 Soyabean P Harvest Index (PHI)

While PHI in soyabean at final grain harvest averaged 79% in this study, Imail (1991) reported that 75% of the P in soyabean is accumulated in the grain. Significant differences were observed for sites, P rates, and their interaction at $p < 0.01$, but not for varieties. The significant effect of site by P rate interaction on PHI observed in this study was due to the responses at Mokwa and Fashola (Table 3). PHI was significantly reduced by 13% at Mokwa when 30 kg P ha^{-1} was applied with another 22% reduction due to a second 30 kg P ha^{-1} increment. Also at Fashola, 30 kg P ha^{-1} significantly reduced PHI by 9%, but a further 11% reduction in PHI by a second 30 P ha^{-1} application was not significant. Averaged over varieties and P rates, PHI was lowest at Mokwa (69%) where available soil P was highest. Reduction in PHI with increased P may be attributed to the enhanced dry matter accumulation resulting from improved P nutrition. Over sites and varieties, there was a significant reduction in PHI as P rate increased. Compared to no P treatment, PHI was significantly lower by 6-10% when P was applied.

Table 4: The effect of site, variety, and P rate on soyabean stover and litter P contents.

	Stover P content (kg P ha^{-1})	*Probability level for significant difference*				
Variety			1	2	3	4
TGx1485-1D	1.36	1	·			
TGx536-02D	1.30	2	0.7792	·		
TGx923-2E	1.84	3	0.0366	0.0191	·	
TGx1670-1F	2.57	4	<0.0001	<0.0001	0.0022	·
Standard Error	0.155					
	Litter P content (kg P ha^{-1})	*Probability level for significant difference*				
Site			1	2	3	4
Mokwa	4.11	1	·			
Fashola	1.13	2	<0.0001	·		
Gidan Waya	0.73	3	<0.0001	0.1940	·	
Kasuwan Magani	0.71	4	<0.0001	0.1680	0.9346	·
Standard Error	0.214					
Variety			1	2	3	4
TGx1485-1D	1.21	1	·			
TGx536-02D	1.65	2	0.1551	·		
TGx923-2E	1.70	3	0.1146	0.8717	·	
TGx1670-1F	2.13	4	0.0037	0.1150	0.1556	·
Standard Error	0.214					
P rate (kg P ha^{-1})			1	2	3	
0	0.92	1	·			
30	1.79	2	0.0018	·		
60	2.30	3	<0.0001	0.0565	·	
Standard Error	0.185					

Numbers 1 to 4 represent the effects tested for significant differences for either stover or litter P content.

3.5 Maize grain P

Results from three sites in this study show that while previous soyabean crop had no significant effect on maize grain P content at harvest, there was a significant effect of site ($p < 0.05$), previous year P rate, and site by previous year P rate interaction ($p < 0.01$). Within site, P application in the previous year had no significant effect on maize grain P at Mokwa and Fashola (Table 5). However, among the sites, maize grain P was significantly higher at Mokwa (3.34 kg P ha^{-1}) and less than 1 kg ha^{-1} at Fashola. The non-significant effect of previous year P application on maize grain P at Mokwa may be attributed to the high level of soil available P. Before the application of P at this site, initial soil test P was adequate (16.2 mg kg^{-1}). P application at Mokwa increased available P further to 33.7 and 42.8 mg kg^{-1} when 30 and 60 kg P ha^{-1} were applied, respectively (OGOKE, 1999). At this sites, therefore, P was not limiting on maize at any of the previous year P rates. Although initial soil test P was low (5.2 mg kg^{-1}) Fashola, P application only increased soil available P in the year following application to 9.8 and 13.6 mg kg^{-1} when 30 and 60 kg P ha^{-1} were applied, respectively. As a result soil P was not adequate for maize at Fashola even when 60 kg P ha^{-1} were applied previous year. In fact purple streaks were observed on maize leaves at all previous year P rates at this site and at Gidan Waya and Kasuwan Magani when no P was applied the previous year. The small P build-up at Fashola may be attributable to the low clay content (3%) of the soil. The application of P in the previous year had no significant effect on maize grain P at Mokwa because initial soil available P was high. Similarly at Fashola, ABDELGADIR (1998) and SANGINGA *et al.* (2000) have reported lack of response to P application by soyabean and cowpea lines, respectively. Increasing P rate applied previous year significantly increased grain P in maize at the third site (Kasuwan Magani). At this site, initial soil available P was low (5.7 mg kg^{-1}) but the relatively higher clay content (15%) may have enhanced P build-up in the soil. Averaged over sites and variety, maize grain P was increased by 35% when 30 kg P ha^{-1} were applied previous year to soyabean, and 66% by 60 kg P ha^{-1} previous year application. This is consistent with the already reported significant residual effect of P on maize grain yield in this study (OGOKE *et al.*, 2001).

3.6 P Balance

With only soyabean grain exported, P balance was negative and not significantly different for all soyabean crop without P amendment (Table 6). This is consequent upon the fact that regardless of duration, the amount of P accumulated in grain when no P was applied was not significantly different for soyabean varieties tested in this study. CASSMAN *et al.* (1993) have similarly reported a negative P balance due to soyabean when there was no P input. The application of P gave positive P balance for all soyabean crop. P balance was not different for the two late varieties of soyabean, or for the early and medium varieties when 30 kg P ha^{-1} were applied. At P rate of 60 kg ha^{-1}, P balance was not different in the plots of Early, Medium, and one of the late varieties (TGx923-2E). The other late variety TGx1670-1F accumulated the larger amount of P in grain and, therefore, gave the significantly least P balance for all soyabean crops.

Table 5: Effects of site and previous year P rate on maize grain P content.

Site	P *rate (kg P ha^{-1})*			*Mean*
	0	*30*	*60*	
Mokwa	3.04	3.75	3.23	3.34
Fashola	0.86	0.80	1.11	0.92
Kasuwan Magani	0.83	1.88	3.52	2.08
Mean	1.58	2.14	2.62	

Standard Error: P rate = 0.170, site = 0.170, site × P rate = 0.290

Table 6: Effect of soyabean crop on P balance in a soyabean-maize rotation.

Soyabean variety	*P Input (kg P ha^{-1})*	*P Balance (kg P ha^{-1})*			
		Soyabean grain exported	*Soyabean grain + stover exported*	*Soyabean grain P + maize grain P exported*	*Soyabean (grain + stover) P + maize grain P exported*
TGx1485-1D	0	-3	-4	-5	-6
	30	+25	+24	+24	+22
	60	+55	+53	+53	+51
TGx536-02D	0	-4	-4	-5	-5
	30	+25	+23	+22	+20
	60	+55	+53	+52	+50
TGx923-2E	0	-3	-4	-6	-7
	30	+24	+22	+22	+20
	60	+54	+51	+53	+50
TGx1670-1F	0	-4	-5	-5	-7
	30	+23	+20	+22	+18
	60	+51	+47	+48	+45

Table 6 also shows that the export of soyabean stover along with grain when soyabean plots received no P treatment resulted in negative P balances in all soyabean plots. P balances were also not significantly different for the soyabean crops at this control P treatment. At both 30 and 60 kg P ha^{-1}, significantly more P was accumulated in aboveground soyabean biomass at harvest in TGx1670-1F. Consequently, the resulting P balances in TGx1670-1F plots at these P treatments were lower. P balances in the plots of Early and Medium soyabean were not significantly different when 30 or 60 kg P ha^{-1} were applied.

In all previous year soyabean plots where P was not applied, whether P was exported only in soyabean grain or in grain with stover, the harvest of maize grain of the following year resulted in negative P balances (Table 6). P balances were not significantly different after the harvest of maize grain in previous soyabean plots that received 30 kg P ha^{-1} when only soyabean grain was exported. When both soyabean grain and stover were exported, P balance was highest in previous Early plots at this same P rate. When 60 kg P ha^{-1} were applied to soyabean previous year, and soyabean grain or grain with stover exported, the harvest of maize grain in previous plots of TGx1670-1F gave a significantly lower P balance compared with the plots of the other soyabean varieties.

4 Conclusions

In this study a significant residual P effect was observed. The application of 30 kg P ha^{-1} in soils where available P was low ($\leq$6.2 mg kg^{-1}) was able to bring soil P to high levels of availability, in the year following application, especially where the clay content was comparatively high. This emphasizes the need to focus P fertilizer application in the cropping system rather than on the single crop. Also with about 79% of the P in the above ground biomass at harvest partitioned in the grain of soyabean, a reduction in the extent of P depletion will be derived from the litter which remain and by returning soyabean stover to the field after threshing.

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References

Abdelgadir, A. H.; *The role of mycorrhizae in soyabean growth in P-deficient soil in the humid tropics*; Ph.D. thesis; Cornell University; 1998.

Ae, N., Arihara, J. and Okada, K.; Phosphorus uptake mechanisms of pigeon pea grown in Alfisols and Vertisols; in: *Phosphorus Nutrition of Grain Legumes in Semi-Arid Tropics*, edited by Johansen, C., Lee, K. K. and Sahrawat, K. L.; ICRISAT, Patancheru, India; 1991.

Ankomah, A. B., Zapata, F., Danso, S. K. A. and Axmann, H.; Cowpea varietal differences in uptake of phosphorus from Gafsa phosphate rock in a low-*P* Ultisol; *Fertilizer Research*; 41:219–225; 1995.

Baligar, V. C. and Bennett, O. C.; NPK fertilizer efficiency - a situation analysis for the tropics; *Fertilizer Research*; 10:147–164; 1986.

Bationo, A. and Mokwunye, A. U.; Alleviating soil fertility constraints to increased crop production in West Africa; *Fertilizer Research*; 29:95–115; 1991.

Cassman, K. G., Singleton, P. W. and Linquist, B. A.; Input/output analysis of the cumulative soyabean response to phosphorus on an ultisol; *Field Crops Research*; 34:23–36; 1993.

Chiezey, U. F., Yayock, J. Y. and Shebayan, J. A. Y.; Response of soyabean (*Glycine max* (L.) Merrill) to N and phosphorus fertilizer levels; *Tropical Science*; 32:361–368; 1992.

Davis, J. G., Manu, A., Hossner, L. R. and Persaud, N.; Phosphorus management of a millet/cowpea intercrop system in sandy dunal soils of western Nigeria; *Journal of Plant Nutrition*; 17:899–910; 1994.

Enwezor, W. O., Udo, E. J., Usoroh, N. J., Ayotade, K. A., Adepetu, J. A., Chude, V. O. and Udegbe, C. I., (Eds.) *Fertilizer Use and Management Practices for Crops in Nigeria (Series No. 2)*; Fertilizer Procurement and Distribution Division, Federal Ministry of Agric., Lagos; 1989; 163p.

Fixen, P. E. and Ludwick, A. E.; Residual available phosphorus in near-neutral and alkaline soils: II, Perspective and quantitative estimation; *Soil Science Society American Journal*; 46:335–338; 1982.

Imail, H.; Nutrient dynamics in tropical cropping systems involving legumes; in: *Phosphorus Nutrition of Grain Legumes in Semi-Arid Tropics*, edited by Johansen, C., Lee, K. K. and Sahrawat, K. L.; pages 195–211; ICRISAT, Patancheru, India; 1991.

Isichei, A. O. and Akobundu, I. O.; Vegetation as a resource: Characterization and management in the moist savannas of Africa; in: *Moist savannas of Africa: Potentials and constraints for crop production*, edited by Kang, B. T., Akobundu, I. O., Manyong, V. M., Carsky, R. J., Sanginga, N. and Kueneman, E. A.; pages 31–48; International Institute of Tropical Agriculture, Ibadan; 1995.

Jagtap, S. S.; Environmental characterization of the moist lowland savanna of Africa; in: *Moist savannas of Africa: Potentials and constraints for crop production*, edited by Kang, B. T., Akobundu, I. O., Manyong, V. M., Carsky, R. J., Sanginga, N. and Kueneman, E. A.; pages 9–30; International Institute of Tropical Agriculture, Ibadan; 1995.

Kumari, C. N. N., Thimmegowda, S., Devakumar, N. and Paramesh, R.; Effect of phosphorus management practices on balance sheet of available phosphorus of soyabean; *Indian Agriculturist*; 36:61–63; 1992.

Manu, A., Bationo, A. and Geiger, S. C.; Fertility status of selected millet producing soils of West Africa with emphasis on phosphorus; *Soil Science*; 152:315–320; 1991.

Ogoke, I. J.; *Response of soyabean to phosphorus fertilizer and its residual effects on subsequent maize performance in the Nigerian moist savanna*; Ph.D. thesis; University of Ibadan; Ibadan, Nigeria; 1999.

Ogoke, I. J., Carsky, R. J., Togun, A. O. and Dashiell, K.; Maize yield following phosphorus-fertilized soyabean in the Nigerian Guinea savanna; in: *Impact, Challenges and Prospects of Maize Research and Development in West and Central Africa*, edited by Badu-Apraku, B., Fakorede, M. A. B., Ouedraogo, M. and Carsky, R. J.; pages 205–213; WECAMAN/IITA, IITA-Cotonou, Benin Republic; 2001.

Okalebo, J. R., Gathua, K. W. and Woomer, P. L.; *Laboratory Methods of Soil and Plant Analysis: A working Manual*; TSBF Programme, UNESCO-ROSTA,

Nairobi, Kenya; 1993.

Pandey, R. K. and McInttosh, J. L.; Phosphorus requirements and management of grain legumes; in: *Phosphorus Requirements for Sustainable Agriculture in Asia and Oceania*; pages 361–370; IIRI; 1990.

Rhodes, E. R., Bationo, A., Smaling, E. M. A. and Visker, C.; Nutrient stocks and flows in West African soils; in: *Restoring and Maintaining the Productivity of West African Soils: Key to Sustainable Development*, edited by Mokwunye, A. U., de Jager, A. and Smaling, E. M. A.; Miscellaneous Fertilizer Studies No. 14; pages 22–32; 1996.

Sanginga, N., Lyasse, O. and Singh, B. B.; Phosphorus use efficiency and nitrogen balance of cowpea breeding lines in a low P soil of the derived savanna zone in West Africa; *Plant and Soil*; 220:119–128; 2000.

Statistical Analysis System Institute Inc.; *SAS/STAT User's guide*; SAS; Cary, NC; 1992.

Stoorvogel, J. J. and Smaling, E. M. A.; Assessment of soil nutrient depletion in sub-Saharan Africa, 1983-2000; Report 28, DLO Winand Staring Centre for Irrigated Land, Soil and Water Research (SC-DLO), Wageningen, Netherlands; 1990.

Webb, J. R., Mallarino, A. P. and M., B. A.; Effect of residual and applied phosphorus on soil test values and yields of corn and soyabean; *Journal of Production Agriculture*; 5(1):148–152; 1992.

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Klasse, Land und Produktionsbeziehungen in Gunung Kidul
Ein Beitrag zur agrarischen Transformation des ländlichen Java

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Abstract

Research on agrarian transformations in rural Java has mainly focused on issues of technology, market penetration, institutional change and demographic pressure resulting in a rapid class polarisation and the dissolution of traditional welfare mechanisms. In examining rural change in the highland regions of Gunung Kidul, Central Java, this paper shows that processes of socio-economic change in Java are not at all uniform. Under certain circumstances, instead of being substituted, so-called "traditional" arrangements and practices are even newly created. Such arrangements can formally function as welfare institutions without being the outcome of welfare-oriented decisions and motivations. Before the 70ties, sharecropping-arrangements were confined to close kin and land rent systems had not been established in the area with farmers co-operating on the basis of "generalised reciprocity". Instead of being institutional features since "time immemorial", such organisational devices emerged as a response to changes in the labour market induced by high rates of out-migration. Despite significant disparities in land ownership, no exclusionary contractual arrangements exist. Rural society did not split into two unequal parts of landowners and marginalised wage workers and patron-client-relationships are only weakly developed. In difference to the lowland areas, agrarian arrangements did not foster "class polarisation", but on the contrary secured the continuity of an institutionally independent peasantry.

Keywords: social change, agrarian arrangements, welfare institutions, Central Java

1 Zum Problem des sozioökonomischen Wandels im ländlichen Java

Im Unterschied zur Sichtweise der javanischen Stadtbevölkerung und entgegen dem Modell der weitgehend egalitären, durch *shared poverty* und *agricultural involution* (Geertz, 1963) charakterisierten Gesellschaft, sind javanische Dorfgemeinschaften keineswegs durch sozioökonomische Homogenität gekennzeichnet.[1] Es gilt heute als sicher, dass javanische Dörfer auch unter traditionellen Bedingungen eine soziale Schichtung aufwiesen. Wie Hüsken und White (1989) anhand von Archivdaten nachweisen konn-

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[1] Geertz leitete sein Konzept der *agricultural involution* aus der Fähigkeit des Nassreises ab, enorme Mengen an Arbeitsinput bei einem konstant niedrigen Produktionslevel zu absorbieren. Laut Geertz steht die javanische Wirtschaftsweise einer Mechanisierung und zunehmenden Landkonzentration im Wege und garantiert auch unter sich ändernden Bedingungen den Fortbestand einer egalitären, aber „armen" Gesellschaft (*shared poverty*).

ten, hat sich bereits im Laufe des 19 Jh. eine zunehmende Differenzierung herausgebildet, im Zuge derer lokale Eliten durch Akkumulation und Vererbung von Amtsland ihre Position festigten konnten.[2] Tiefgreifendere soziale Wandlungsprozesse sind indes verstärkt seit den 70iger Jahren zu vermerken. Das vorherrschende Paradigma sieht vor allem die „Grüne Revolution" der 60iger und 70iger Jahre als Ursache einer wachsenden ökonomischen Polarisierung und sozialen Desintegration (Griffin, 1974; Collier, 1978). Ländliche Differenzierungsprozesse erscheinen hier primär als eine Substitution von „traditional village institutions and practices" (Hart, 1986, S. 5) durch einen freien und wettbewerbsorientierten Arbeitsmarkt. Demnach gehen moderne Technologien und staatliche Intensivierungsprogramme - konkret: die Einführung hybrider Reissorten - einseitig zu Lasten der Landlosen, da sich größere Landeigentümer zunehmend ihrer normativen Verpflichtung der Bereitstellung von Einkommenschancen entziehen und statt dessen unpersönliche Geldlohnbeziehungen bevorzugen. Collier (1978) und Harts-Broekhuis und Palte-Gooszen (1977) verweisen hier exemplarisch auf das Verschwinden der Wohlfahrtsinstitution der „offenen Ernte", die früher die freie Partizipation an der Ernte der Wohlhabenden gesichert haben soll. Mantra (1988) und Stoler (1977) betonen indes die prekäre Situation landloser Frauen, deren Erwerbschancen mit der Substitution des Reismesserchens („Frauengerät") durch die Handsichel („Männergerät") weggebrochen sind ohne dass alternative Einkommensmöglichkeiten geschaffen wurden.

Einen weiteren Focus bildet die Analyse institutioneller Arrangements, die den Zugang zu agrarischen Ressourcen kontrollieren. So zeigt Hart (1986) wie landbesitzende Eliten ihre Position vermittels exklusiver Abmachungen, die zugleich eine rigidere Kontrolle über privilegierte Arbeiter implizieren, festigen. In diesen, unter dem Term *kedokan* bekannten Arrangements erledigen privilegierte, an einen Landbesitzer gebundene Arbeiter kostenlos das Pflanzen und Instandhalten der Nassreisfelder gegen die Zusage eines exklusiven Teilhaberechts an der Ernte. Nicht privilegierte Arbeiter sind indes von der Partizipation an solchen Arrangements (und somit an der Teilnahme an Ernteeinsätzen) ausgeschlossen.

Die einschlägigen Fallstudien kommen zwar zu verschiedenen Ergebnissen; basieren aber gleichermaßen auf der Prämisse, institutionelle Arrangements und soziale Differenzierungen monokausal aus den Besonderheiten des Nassreisanbaus abzuleiten. Sie implizieren außerdem zwei zentrale Konstanten ländlicher Entwicklung: (1) Es findet eine zunehmende „Verdrängung der Armen" aus der Landwirtschaft statt und (2) die ländliche Diversifizierung vollzieht sich unter den Bedingungen niedriger ländlich-urbaner Migrationsraten. Ihr Erklärungspotential dürfte deshalb an den Gemeinschaften der Hoch- und Hügelländer, deren traditionelle Wirtschaftsform keineswegs „hydraulisch" organisiert

[2] Von der Kolonialzeit bis in die Gegenwart hinein erhalten javanische Bürgermeister und Dorfsekretäre keine Besoldung, sondern leben von sogenanntem „Amtland" (*bengkok*), das ihnen für die Dauer ihrer Amtszeit vom Staat gewährt wird. Durch die gängige Praxis, die Position des Bürgermeisters vom Vater auf den Sohn zu übertragen und dem Entstehen von „Dorfbeamten-Dynastien" sind diese *de jure* öffentlichen Ländereien nicht selten in einen *de facto* Privatbesitz übergegangen.

ist, an empirische Grenzen stoßen.[3] Nach wie vor aber zeichnen sich sozioökonomische Fallstudien zum ländlichen Java durch eine Präferenz für das flache Land und die Nassreisökonomie aus und vermitteln so ein einseitiges Bild des kontemporären Java. Der vorliegende Beitrag soll helfen, diese Lücke vermittels einer vergleichenden Analyse der institutionellen und sozioökonomischen Wandlungsprozesse in den zentraljavanischen Hügel- und Hochlandregionen zu schließen.

2 Die Untersuchungsregion: Geomorphologie und Sozioökonomie

Die nachfolgenden Ausführungen basieren auf einer 18monatigen Feldstudie, die ich von Dezember 95 - Juni 97 im Bezirk Karangmojo, Landkreis Gunung Kidul (Mitteljava) durchführte. Geomorphologisch wird das Gebiet von Karst- und Kalksteinlandschaften bestimmt, die sich bis auf 800 m erheben. Die Erosionsrohböden auf Festgestein (Lithosole) zeichnen sich durch äußerst geringe Nutztiefen aus, die der Expansion des Nassreisanbaus ökologische Grenzen setzen. Die Landnutzung wird folglich von Trockenfeldern und Hausgärten beherrscht, die zusammengenommen 76,3% der Gesamtfläche stellen, indes auf die Nassreisfelder nur 6,3% entfallen (Monographie des Landkreis Karangmojo 1995). Bis Ende der 70iger Jahre stellte keineswegs der Reis, sondern Mais und Maniok die primäre Ernährungsgrundlage der Landbevölkerung. Nicht nur ökologisch, auch sozioökonomisch unterscheidet sich die Region von den Dörfern der javanische Tiefebenen: So kannte man weder eine nach Landbesitz abgestufte Klasseneinteilung, noch die für das Tiefland charakteristische Institution der „offenen Ernte". Exklusive Arrangements als konstitutives Element der Patron-Klient-Beziehung kommen trotz einer hohen Landlosigkeit nicht vor. Häufige Kauftransaktionen dokumentieren eine hohe Mobilität des Produktionsfaktors Land. Laut meinem Zensus (Jan. 96) waren 55% aller im Landkreis geborenen Lebendpersonen emigriert, 61% davon in die Hauptstadt Jakarta. Dieser Befund ist weder mit dem klassischen Bild der Javaner als „people very tightly tied to their land" (Mantra, 1988, S. 207) in Einklang zu bringen, noch reflektiert er die zentralen sozioökonomischen Trends, die gemeinhin zur Kennzeichnung der Situation javanischer Dorfgemeinschaften hervorgehoben werden.

Der Durchschnittslandbesitz von 0,4 ha pro Haushalt verschleiert die große Streuung der Parzellen. 38% der Haushalte besitzen kein oder weniger als 0,1 ha Land; indes 20% der Dorfbewohner über 64% des Landes verfügen. Im Fall der Nassreisfelder (*sawah*) ist die asymmetrische Besitzverteilung noch signifikanter; so kontrollieren 8% der Bauern 70% aller bewässerten Felder. Der Anteil käuflich erworbener Parzellen am privaten Gesamtbesitz (*holding*) ist mit 65% signifikant hoch. Vor allem während der schweren Hungerkrisen (*paceklik*) von 1963 und 1967 hatte sich die Grundbesitzverfassung in Gunung Kidul neu geordnet als es einzelnen, im Naturalienhandel aktiven Familien gelang ihren Landbesitz durch Zukauf und Pfändung enorm zu vergrößern.

Trotz einer auf dem Landbesitz basierenden Differenzierung bildeten einst symmetrische, unbezahlte Austauschbeziehungen (*sambatan*) die Grundlage der Landbewirtschaftung. Eine Ausnahme galt bei der Ernte: Hier praktizierte man das *bawon*-Prinzip, bei dem

[3] Immerhin besteht 1/3 der Fläche Javas aus Hochländern und machen Trockenfelder und Hausgärten rund 50% der landwirtschaftlichen Nutzflächen aus (Hefner, 1990, S. 16).

jedem Helfer je 1/5 der eingebrachten Produktmenge zustand. Das Vorherrschen dieser „generalisierten Reziprozität“ bis Mitte der 60iger Jahre hinein ist ein Indiz dafür, dass bis zur *paceklik*-Zäsur eine starke Fraktion von unabhängigen Bauern existiert haben muss. Folgende Indikatoren stützen diese These: Teilbauverhältnisse (*sharecropping*) finden sich erst seit den 60iger Jahren und kommen zunächst nur zwischen Verwandten vor; zwischen Nicht-Verwandten treten sie indes nicht vor 1970 in Erscheinung. Die in mitteljavanischen Tieflandgemeinden übliche Differenzierung von Besitzern von Hofparzellen plus Ackerland (*kenceng*) und „Nur-Hofparzellen-Besitzern“ (*setengah kenceng*) ist gänzlich unbekannt. Gleichermaßen werden rezente Immigranten von außerhalb nicht von Erstsiedlern terminologisch unterschieden. Es gibt keine Indices von formalisierten, mit Namen versehenen Statusgruppen. Gewiss war Gunung Kidul auch in der Vergangenheit keine homogene Gesellschaft. So kannte man in Karangmojo durchaus Patron-Klient-Verhältnisse, in welchen der Patron gewisse Subsistenzgarantien für seinen Klienten übernahm. Für die im Tiefland übliche Praxis, nach der die Klienten bereits als Kinder Aufnahme im Haushalt des Patrons fanden (Hart, 1986, S. 119) gibt es indes keine Hinweise. Auch konnte sich der Klient jederzeit aus dem Patronage-Verhältnis lösen oder während seines Bestehens Arbeiten auf den Feldern von Dritten wahrnehmen. Teilbauverhältnisse stellten in Abgrenzung zum stratifizierten sozialen System der Ebenen (Jay, 1969; Hart *et al.*, 1989) kein konstitutives Element einer solchen Beziehung dar. Insgesamt lässt sich zwar eine sozioökonomisch heterogene Gemeinschaftsstruktur feststellen, diese scheint aber eher durch eine diffuse Subordination der Schwachen, denn durch die Existenz von klar identifizierbaren Statusgruppen charakterisiert.

3 Agrarische Arrangements im kontemporären Karangmojo

Die Schlussfolgerung einer traditionell relativ starken institutionellen Unabhängigkeit wird durch mehrere Besonderheiten gleichzeitig unterstrichen. So gab es im Untersuchungsgebiet bis zu Beginn der 70iger Jahre keine Geldpacht; diese hat vielmehr simultan mit der Ausweitung des Teilbaus auf nicht-verwandte Anteilspächter Eingang in die dörflichen Agrarbeziehungen gefunden. Pachtbeziehungen und Teilbauverhältnisse sind gleichermaßen durch ein hohes Maß an ökonomischer Eigenverantwortlichkeit gekennzeichnet, die wenig Gemeinsamkeiten mit dem javanischen Landleben als ein „dense web of finely spun work rights and responsibilities“ (Geertz, 1963, S. 99) aufweisen. Fremdbewirtschafter entscheiden stets eigenverantwortlich über die Nutzungsform und die angewandte Technologie. In allen dokumentierten Fällen von Lohnarbeit partizipierte der Landbesitzer aktiv an der Kultivierung seiner Parzellen. Fassen wir die Gruppe der eigenständigen, nicht in Teilbau- oder Pachtverhältnisse eingebundenen Haushalte und die Gruppe derer, die Teile ihres Landbesitzes der Fremdbewirtschaftung überlassen zu einer Kategorie von agrarisch-institutionell unabhängigen Haushalten zusammen, so sind dies immerhin 69,1% aller bäuerlichen Haushalte. Dies sagt selbstverständlich noch nichts über den Lebensstandard der Haushalte aus. Es ist aber nicht von der Hand zu weisen, dass die in diversen Fallstudien für das Tiefland nachgewiesene Situation von 1/3 unabhängigen zu 2/3 abhängigen Haushalten (Jay, 1969, S. 266; Hüsken und White, 1989, S. 144; Hart, 1986, S. 3) hier mit Sicherheit nicht gegeben ist.

3.1 Teilbauverhältnisse und Geldpacht

Generell definieren sich Teilbauverhältnisse (*bagi hasil*) über die an ein standardisiertes Verhältnis gebundene Teilung des Naturalertrages zwischen Eigentümer und Pächter. In Gunung Kidul gibt es zwei Grundformen des Teilbaus: Das als *maro* bekannte System sieht die paritätische Teilung des Ertrages von 50:50 vor und wäre demnach als *Halbpacht* zu bezeichnen. Es wird in der Nassreiswirtschaft stets, im Maisanbau indes nur in der Regenperiode praktiziert. Die im Tiefland üblichen Vorauszahlungen von „Handgeldern" (RÖLL, 1976) an den Landbesitzer kommen in Gunung Kidul nicht vor. In den allermeisten Fällen erbrachten die Bewirtschafter (Geldpächter und Teilbaupächter) die vollen Produktionskosten. Lediglich die Landsteuer wurde von den Landeigentümern übernommen. In mehreren Fällen partizipierten die Landbesitzer aktiv bei der Pflanz- und Erntearbeit auf ihren durch Teilpacht vergebenen Feldern. Hier zeigt sich deutlich, dass Teilbauverhältnisse weit weniger die Anerkennung von sozialen Statusgruppen implizieren als dies im Tiefland der Fall ist. Eine solche Partizipation, bei der ein Landbesitzer seinem eigenen Teilpächter zu Hilfe kommt (und sei dies um den eigenen Anteil zu sichern), dürfte mit der stringenten Statuskonzeption der Ebenen (JAY, 1969; HART, 1986) wohl kaum zu vereinbaren sein.

Das von den Hügelbewohnern als *mertelon* bezeichnete Parzellenteilbau-System mit dem Teilverhältnis von 1/3 zu 2/3 ist nur im Maisanbau in der Trockenzeit üblich. Ähnlich wie beim *maro*-System übernimmt der Teilpächter die kompletten Produktionskosten, indes der Landeigentümer die Landsteuern entrichtet. Im Gegensatz zum gleichnamigen, in der nahegelegenen Tiefebene des Nachbarbezirks Klaten üblichen System (RÖLL, 1976, S. 94) ist der „Drittelbau" im Landkreis Karangmojo nicht durch das Teilbauverhältnis von 1/3 für den Pächter zu 2/3 für den Grundeigentümer, sondern durch das umgekehrte Verhältnis definiert, d.h. dem Teilpächter stehen gewohnheitsrechtlich 2/3 des Naturalertrags zu.

In allen Pachtabmachungen bestimmt allein der Grundeigentümer über die Form des Arrangements, d.h. Teilbau oder Geldpacht. Er hat indes keinen Einfluss auf die angebauten Nahrungspflanzen und die Form der Landnutzung (z.B. Monokultur oder Mischsystem). Sowohl die Tatsache, dass der Pächter die vollen Produktionskosten übernimmt als auch der Umstand, dass man ihm freie Hand in der Gestaltung des Arrangements lässt unterstreichen den obigen Befund, dass Teilpächter eher die Position eines *Juniorpartners* mit selbständigen unternehmerischen Funktionen als die eines von seinem Patron abhängigen und dessen Anweisungen ausführenden *Anteilsarbeiters* innehaben. Die in den Tieflandzonen sporadisch oder permanent praktizierte Supervison von Teilpächtern und Landarbeitern (vgl. JAY (1969), HART (1986)) vermittels Dritter (*mandor*) kommt folglich im Untersuchungsgebiet nicht vor.[4]

[4] Meine Frage nach der Existenz von „Supervision" durch Dritte und mein Hinweis auf ihre Relevanz in anderen Regionen lösten bei Landbesitzern und Pächtern nicht nur Verwunderung aus, sie wurden von einigen Informanten sogar als „exotisch" (*aneh*), „lächerlich" (*omong kosong*) und „blödsinnig" (*bodoh*) bezeichnet.

In allen Fällen handelte es sich bei den Landbesitzern, die eine oder mehrere Parzellen der Fremdbewirtschaftung überließen um Haushaltsvorstände die ihren Landbesitz aus Gründen des Alters, Krankheit, des Fehlens familieninterner Mitarbeiter (Emigration der Jüngeren!) oder der Wahrnehmung eines nicht-agrarischen Hauptberufs nicht selbst bewirtschaften konnten. Diese pragmatischen Begründungen stimmen mit der objektiven Situation insofern überein, als es keinen einzigen Fall gibt, in dem ein Haushalt zugleich als Verpächter einer Parzelle „A" und (Teil)-Pächter einer Parzelle „B" in Erscheinung trat. Laut GEERTZ (1963) stellt aber exakt diese Praxis seit jeher ein zentrales Merkmal der Tieflandgemeinden dar:

> „A man will let out part of his one hectar to a tenant .... while at the same time seeking tenancies on the lands of other men, thus balancing his obligations to give work (to his relatives, to his dependants, or even to his close friends and neighbours) against his own subsistence requirements" (ebd., S. 99).

Diese Situation trifft auf die Arrangements der Untersuchungsregion definitiv nicht zu, da diese nicht in normativen Prinzipien begründet sind, sondern vielmehr eine Reaktion auf äußere Verhältnisse darstellen. Dennoch ist festzuhalten, dass die durch Überalterung charakterisierte demographische Struktur die Zugangschancen auf Teilpachtverhältnisse deutlich erhöht. Der Teilbau als solcher stellt jedoch weder eine dörfliche Solidarinstitution im Sinne der *moral economy* (SCOTT, 1976), noch einen „mechanism through which people help their less affluent relatives" (HEFNER, 1990, S. 131) dar. Beide Aspekte spielen in der *Begründung* kontemporärer Pachtabmachungen keine Rolle, auch wenn sie in der *Konsequenz* eine redistributive Funktion in der Landkontrolle implizieren.[5]

Im Gegensatz zum Teilbau wird im Fall der Geldpacht dem Landbesitzer ein individuell ausgehandelter Betrag in Bar bezahlt, welcher den Pächter zu einer zeitlich befristeten Nutzung der Parzelle berechtigt. Während eine Präferenz für den Teilbau offensichtlich bei denjenigen Landeigentümern vorherrscht, die aufgrund ihrer Lebenssituation eine langfristige Fremdbewirtschaftung ihrer Parzellen vorsehen, steht im Fall der Geldpacht (*jual tahunan*) primär die *kurzfristige* Verfügbarkeit von Bargeld im Vordergrund. Da die Verpachtung zumeist in aktuellen Finanzproblemen begründet ist, markiert sie nicht selten den ersten Schritt von permanenten Landverkäufen.

3.2 Vom Bawon-System zur modernen Lohnarbeit

Einen zentralen Wandlungsprozess stellt die Substitution des Ernte-Naturallohnprinzips (*bawon*) dar, welches entgegen allen Erwartungen nicht im Reisanbau, sondern im Mais- und Sojaanbau bevorzugt wird. Diese, in unserem Sprachbereich als „Fünftelsystem"

[5] Bezogen auf den Landbesitz stehen jeder Person in Karangmojo im Durchschnitt 0,11 ha Land zur Verfügung (sd = 0,24). Berechnen wir nun das *kontrollierte* Land (d.h. Landbesitz plus/minus der gepachteten/verpachteten Flächen entsprechend der Ernteanteile), dann steigt dieser Wert auf 0,16 ha an, während sich die Standardabweichung auf 0,13 halbiert. Die Unterschiede im Zugang zu Nutzland werden durch Teilpacht-Arrangements statistisch signifikant verringert, womit ihre redistributive Wirkung als bewiesen gelten kann.

bekannte Institution garantiert jedem Erntehelfer je 1/5 des individuell eingebrachten Naturalertrags. Das herrschende Paradigma hat das *bawon* fast ausschließlich im Kontext der „offenen Ernte" analysiert und somit primär seine Rolle als Wohlfahrtsaspekt hervorgehoben (STOLER, 1977; COLLIER, 1978; MANTRA, 1988). Dieses Konzept schien mit der empirischen Situation kaum vereinbar, da vor allem die größeren Landbesitzer das Verschwinden des *bawon* beklagten, indes die Landarbeiter eindeutig das Geldlohnprinzip vorzogen. Landeigentümer verwiesen darauf, dass das *bawon* effektiver gewesen sei, da es die Arbeiter zum fleißigen Arbeiten anhielt, indes den Lohnarbeitern heutzutage zwar feste Tagessätze zustehen, sie dafür aber schlechter motiviert seien! Das zügige Erledigen der Erntearbeit hat angesichts des notorischen Arbeitermangels und der fatalen Folgen im Falle des Einsetzens des Regens (v.a. im Fall der für den Markt produzierten Sojabohne, die in abgeerntetem Zustand keine Feuchtigkeit verträgt) für den Landbesitzer höchste Priorität. In diesem Sinne gibt es gute Gründe für die Annahme, dass es sich hier weniger um eine Wohlfahrtseinrichtung als vielmehr um eine Produktionstechnik zur Beschleunigung des Ernteprozesses handelt.

Unsere Annahme, dass das *bawon*-System aller Wahrscheinlichkeit nach auch früher keine Wohlfahrtsinstitution war, lässt sich schon daraus ableiten, dass sein wichtigstes Korrelat als Wohlfahrtseinrichtung, nämlich die freie Partizipation von Jedermann an der Ernte, in Gunung Kidul gänzlich unbekannt ist. Ich möchte an dieser Stelle ausdrücklich darauf hinweisen, dass es in der ethnographischen Literatur seit jeher eine divergente Interpretation des *bawon* gab, die aber durch das seit den siebziger Jahren vorherrschende Paradigma verdrängt worden ist. So wies bereits G. H. van der Kolff 1936 in seiner historischen Abhandlung über die Entwicklung javanischer Dorfinstitutionen darauf hin, dass das *bawon* primär als Produktionstechnik in Situationen von Arbeitskräftemangel zur Anwendung kam (VAN DER KOLFF, 1936, S. 37). Ähnlich hatte K. J. Pelzer in seiner Studie „Pioneer Settlement in the Asiatic Tropics" (PELZER, 1945) das *bawon* als eine Strategie der Kolonisationsbeamten in Südsumatra beschrieben, durch die der Erschließungsprozess agrarischer Nutzflächen in den Regenwaldrandzonen erheblich beschleunigt werden konnte!

Ein konstitutives, dem Teilbau verwandtes System ist die in den Tiefebenen übliche Ausführung unbezahlter Arbeit gegen eine spätere Teilhabe an der Ernte auf der Basis exklusiver Patronage (*kedokan*). Konkret bedeutet dies, dass ein Landarbeiter die Bepflanzung und Instandhaltung von Nassreisparzellen ohne direkte Entlohnung übernimmt. Vielmehr werden Routinearbeiten auf der Basis einer „verzögerten Belohnungserwartung" ausgeführt, die der Arbeitskraft ein exklusives und sicheres Vorrecht bei der Ernte zu einem fixen Naturalanteil in Aussicht stellt. Wie HART (1986, S. 193) zeigen konnte, führt dieses System unweigerlich zum Ausschluss derer aus der Landarbeit, die nicht in solche Abmachungen eingebunden sind. Erwartungsgemäß kommt dieses System in Gunung Kidul nicht vor. Allerdings besteht eine äußerlich ähnliche, in ihren Konditionen aber abweichende Praxis in Form eines *Bonussystems*, welches zusätzliche Naturalgaben oder Kleinkredite für „treue" Arbeiter vorsieht. Diese Privilegien unterscheiden sich vom Typ der selektiven Patronage (*kedokan*) vor allem dadurch, dass alle von den Arbeitern ausgeführten Tätigkeiten nach geregelten Tagessätzen unmittelbar

entlohnt werden. Sie implizieren des weiteren keine Ausschlussmechanismen für andere Lohnarbeiter, die keine bevorzugte Position besitzen. Auch ist weder der Umfang dieser Sonderzahlungen gewohnheitsrechtlich geregelt, noch existiert ein indigener Term für diese Praxis.

Die Lage in Karangmojo unterscheidet sich vom Tiefland primär dadurch, dass hier die Frage der institutionellen Abhängigkeit gewissermaßen „auf den Kopf gestellt" ist, da nicht die Gruppe der Lohnarbeiter aus Gründen der Abhängigkeit von Arbeit Minimalkonditionen akzeptieren muss, sondern vielmehr die größeren Landbesitzer aufgrund der Abhängigkeit von Arbeitskräften offensichtlich ihrerseits versuchen, diese vermittels eines Bonussystems an sich zu binden. Alle als Lohnarbeiter (*buruh tani*) in Erscheinung tretenden Akteure gehören entweder landbesitzenden Haushalten an oder sie bestellen zumindest eine Parzelle als Fremdbewirtschafter. Es gibt in Karangmojo somit keine distinktive Klasse von „reinen" Landarbeitern, wie sie die in den tiefer gelegenen Regionen vorzufindenden *kuli* darstellen (vgl. HART *et al.* (1989)). Fast alle Landarbeiter führen einen eigenen Haushalt und nehmen an den Versammlungen der Bauerngruppen, Gebetszirkel und Nachbarschaftstreffen teil; d.h. sie stellen aus kultureller Sicht vollwertige Mitglieder ihrer Gemeinschaft dar und befinden sich damit keinesfalls in einer sozial marginalisierten Position, wie dies z.B. Robert Jay und Gillian Hart für die gesellschaftlich stratifizierten Ebenen feststellten (JAY, 1969; HART, 1986).

4 Diskussion der Ergebnisse

Fassen wir die Ergebnisse unserer Diskussion zusammen, so sind die Auswirkungen agrarischen Wandels auf die soziale Schichtung keineswegs uniform. Obwohl in den Hügelregionen durchaus Statusunterschiede bekannt sind, ist die Organisation der Landarbeit stärker als in anderen Regionen von der kollateralen Beziehung zwischen Gleichen und weniger von der linearen Beziehung zwischen Ungleichen geprägt. Das soziale Merkmal der agrarisch-institutionellen Unabhängigkeit setzt sich auch nach dem Entstehen von Teilbau, Geldpacht und Lohnarbeit fort, da keine exklusiven Patronageverhältnisse vorliegen. So kann ein Landarbeiter jederzeit die Anfrage eines Landbesitzers (selbst eines Staatsbeamten) ablehnen, wenn er am betreffenden Tag bereits „ausgebucht" ist. Dass in der Region weder eine gleichförmige Kapitalisierung von Produktionsbeziehungen, noch ein Prozess in Richtung einer Zwei-Klassen-Gesellschaft von kommerzialisierten Farmern und landlosen Tagelöhnern wirksam ist, lässt sich schon daraus ableiten, dass in den letzten 2 Jahrzehnten nicht nur die Lohnarbeit, sondern auch Teilbau und Geldpacht zugenommen haben. Zwar kam es nach der historischen Zäsur der 60iger Jahre (*paceklik*) zu einer steten Polarisierung im Landbesitz, keineswegs aber zu einer „Verdrängung der Armen" aus der Landwirtschaft. Die demographische Situation führt trotz einer zunehmenden Landkonzentration nicht zu einer eigentlichen Schichtungsgesellschaft, da ältere Landbesitzer aufgrund der Emigration ihrer Kinder ihr Land oft nicht mehr selbst bewirtschaften können. Plausibelerweise bevorzugen die größeren Landbesitzer eben gerade nicht den Rückgriff auf Lohnarbeiter, sondern fast immer die Fremdbewirtschaftung: Aufgrund des Vorherrschens von fixen Lohnstandards treiben nämlich Lohnarbeiter ab einer bestimmten Landbesitzgröße die Produktionskosten un-

verhältnismäßig in die Höhe! So erfüllen Teilbauverhältnisse *de facto* eine redistributive Funktion in der Landkontrolle, auch wenn den Landbesitzern ein legitimes Eigeninteresse unterstellen werden kann.

Auf die Problematik traditioneller Wohlfahrtsinstitutionen wurde bereits im Zusammenhang mit dem *bawon*-System hingewiesen. Fassen wir das Gesagte zusammen, so lässt sich die Erkenntnis ableiten, dass dörfliche Institutionen *formal* durchaus wie Solidarinstitutionen organisiert sein können, ohne in irgendeiner Form das Ergebnis einer bewusst wohlfahrtsorientierten Entscheidung oder Strategie darzustellen. Auch der technologisch bedingte Ausschlussmechanismus von Frauen im Produktionsprozess durch die Einführung der Sichel fällt in unserem Fall nicht ins Gewicht. Aufgrund der althergebrachten Dominanz von Trockenanbaupflanzen - den sogenannten „non-rice-food-crops" - ist die geschlechtsspezifische Arbeitsteilung eher schwach ausgeprägt. So wird z. B. die Mais- und Sojaernte seit jeher (von Männern und Frauen gemeinsam) mit Handsicheln ausgeführt. Anders als im Tiefland bedurfte es deshalb auch keiner Überwindung von kulturellen Schranken, um Frauen bei der Ernte hybrider Reissorten mit der Sichel anzustellen.

Das Problem der analytischen Vernachlässigung der Hoch- und Hügelländer ist meines Erachtens, dass die Situation javanischer Bauern fast ausschließlich im Kontext von Technologie, den Kräften des Marktes und demographischem Druck analysiert werden unter der Annahme, dass diese (in den zentralen Alluvialebenen ja durchaus wirksamen) Faktoren in allen Mikroregionen konstant seien. Da sich die empirische Situation unserer Untersuchungsregion diesen Stereotypen in fast allen Bereichen entzieht, scheint eine stärkere Konzentration auf die peripheren Regionen Javas für die Zukunft unerlässlich.

Literatur

Collier, W. L.; Rural development & the decline in welfare institutions in Java; Honolulu; 1978.

Geertz, C.; *Agricultural involution. The process of ecological change in Indonesia*; Berkeley; 1963.

Griffin, K.; The political economy of agrarian change: The Green Revolution; London; 1974.

Hart, G.; *Power, labor and livelihood: Processes of change in rural Java*; Berkeley; 1986.

Hart, G., A. Turton und B. White (Herausgeber); *Agrarian Transformations. Local Processes and the State in Southeast Asia*; Berkeley: University of California Press; 1989.

Harts-Broekhuis, A. und H. Palte-Gooszen; *Demographic aspects of poverty in a Javanese Village*; Utrecht; 1977.

Hefner, R.; *The political economy of Mountain Java. An interpretative history*; Berkeley; 1990.

Hüsken, F. und B. White; Java: Social Differentiation, Food Production and Agrarian Control; in: Hart, G., A. Turton und B. White (Herausgeber), *Agrarian Transformations. Local Processes and the State in Southeast Asia*; S. 235–265; Berkeley:

University of California Press; 1989.

Jay, R.; *Javanses villagers. Social relations in rural Modjokuto*; Yogyakarta; 1969.

van der Kolff, G. H.; *The historical development of the labour relationships in a remote corner of Java as they apply to the cultivation of rice*; New York; 1936.

Mantra, I. B.; *Population movements in two Javanese communities*; Yogyakarta; 1988.

Pelzer, K. J.; Pioneer settlements in the Asiatic tropics; New York; 1945.

Röll, W.; *Die agrare Grundbesitzverfassung im Raume Surakarta. Untersuchungen zur Agrar- und Sozialstruktur Zentral-Javas*; Wiesbaden; 1976.

Scott, J.; *The moral economy of the peasant. Rebellion and subsistence in Southeast Asia*; Yale; 1976.

Stoler, A.; Rice harvesting in Kali Loro: A study of class and labor relations in rural Java; *American Ethnologist*; 4:678–698; 1977.

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Long-term Trend in Pre-grazing Horizontal Distribution of Herbage Mass in Bahiagrass Pasture (*Paspalum notatum* Flügge)

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Abstract

Grazing by cattle plays a main role in development of spatial heterogeneity in pasture and through it, as well, in stability of particular grazing system. In this study the first five years (1995-1999) of a long-term trial in pre-grazing distribution of herbage mass in bahiagrass pasture, utilised under the same repeated grazing management are shown. Herbage mass was non-destructively estimated with an electronic capacitance probe at 182, 50 by 50 cm locations along 2 permanent line transects. The changes in pre-grazing horizontal distribution of herbage mass during five grazing seasons were measured always on the same position on two transects just before the beginning of each grazing period (27 occasions). The pre-grazing herbage mass shows spatially heterogeneous distribution, as it was indicated by the coefficient of variation in the range from 0.221 (August 1998) to 1.107 (September 1995) for all measurement dates. This research had also the aim to quantify the stability of sward in a long-term distribution of pre-grazing herbage mass in bahiagrass pasture, and the calculated correlation coefficient of multilinear regression ($r=0.612$) was highly significant ($p < 0.001$). Anyway, it is difficult to say weather this pasture is going to maintain the same spatial pattern of herbage mass in, for example, next five years. That is, to continue this research in the future is necessary task in obtaining more information about spatial heterogeneity of vegetation in bahiagrass pasture, and implication of agro ecological advantages to grazing systems.

Keywords: bahiagrass, Paspalum notatum, grazing, herbage mass, spatial heterogeneity

1 Introduction

Japan is located in the heavy rainfall zone, and there are no natural grasslands as the climax vegetation except for the alpine grasslands, windward grasslands, coastal grasslands and moor that cover very limited areas. In the summer, the southeast of Japan (islands Kyushu, Shikoku) records more than 24°C of mean temperature and the climate is similar to that in the subtropics. Therefore summer kill of temperate grasses and clover in this region, particularly in the lowlands is serious problem. A rainy season

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lasts for about a month and although very favourable for rice cultivation in the case of animal husbandry, it impairs hay and silage making because this season coincides with the first cutting period of grasses. Utilisation of improved artificial pastures was initiated long time ago, and concerning pasture plant species, bahiagrass (*Paspalum notatum* Flügge) was introduced from the USA and highlighted as a one of promising species in that region. It is a sod forming, warm seasonal perennial, wide spread in the low-attitude regions of southeast Japan and used for both grazing and hay (PAKIDING and HIRATA, 1999).

Grazing by cattle plays a main role in development of spatial heterogeneity in pasture and through it, as well, in stability of particular grazing system. The investigation of systems heterogeneity (the scales, processes and impact of spatial and temporal variability on system characteristics, stability and productivity) is clearly a major growing area (ILLIUS and HODGSON, 1996). Heterogeneity of pasture and the uneven distribution of herbage mass generally appear as a result of selective and patchy grazing by large herbivores. This may be also associated with spatial distribution of different forage species, with patchiness of the resource base (e.g. soil depth or nutrient content) or, most importantly, with the spatial heterogeneity or variation in sward structure resulting from prior selective grazing, (TAINTON *et al.*, 1996). Therefore, the existence of an optimal spatial and temporal scale for patch assessment and decision making is characterized by the animal and vegetation properties and to understand better these decisions require sampling of the vegetation for long enough to provide sufficiently reliable information, (GORDON and ILLIUS, 1992).

In this study the first five years of a long-term trial in pre-grazing distribution of herbage mass in bahiagrass pasture are referred. The changes in pre-grazing horizontal distribution of herbage mass during five grazing seasons (1995-1999) are shown in this paper, measured always on the same position on two transects just before the beginning of each grazing period.
However, there is a little information available about long-term distribution of herbage mass and stability of spatial pattern in bahiagrass pasture grazed by cattle.

2 Materials and Methods

2.1 Study site and grazing management

The experiment was conducted from May 1995 to October 1999 on a 1.1 ha paddock (1.1 ha) of bahiagrass *(Paspalum notatum* Flügge cv. Pensacola) pasture at the Sumiyoshi Livestock Farm (31°59'N,131°28'E), Faculty of Agriculture, Miyazaki University.

The paddock was one of five paddocks (total area=6.3 ha) rotationally grazed by Japanese Black cows. Grazing was conducted as follows: five times in 1995 (31 animals), 1996 (28-32 animals) and 1999 (30-33 animals), six times in 1997 (29-33 animals) and 1998 (31-34 animals) from May to October. The everyday grazing was daily grazing from 09.00-16.00 h. The duration of each rotational grazing period was within 2-7 days interval. The total length of grazing period was 31, 23, 22, 32 and 30 days in 1995,

1996, 1997, 1998 and 1999 respectively. The average live weight of the animals was about 450 kg.

The annual fertilization rates per ha were 81 kg N (split application in April and September), 12 kg P (April) and 19 kg K (April) in 1995; 77 kg N (March and August), 20 kg P (March) and 30 kg K (March) in 1996; 45 kg N, 20 kg P and 30 kg K (all in April) in 1997; 77 kg N (April and September), 27 kg P (April) and 40 kg K (April) in 1998; 70 kg N (April and August), 18 kg P (April) and 20 kg K (April) in 1999.

2.2 Measurements

The pre-grazing distribution of herbage mass was measured during five grazing seasons (1995-1999). HIRATA and FUKUYAMA (1997) developed a sward-based method using an electronic capacitance probe. An electronic capacitance probe (Pasture Probe™, Mosaic System Ltd., New Zealand) was used to measure capacitance (corrected meter reading-CMR) at 1m intervals along 2 fixed transects. Each transect was 90 m long and the CMR was determined at 182 positions. At each position, the CMR was measured 5 times within an area of 50 $\times$ 50 cm and the mean value of the 5 measurements was recorded as the CMR of that place. The CMR was converted into herbage mass (gDM$(2500\text{cm}^2)^{-1}$) with height of 3 cm, using a calibration equation, which was developed for each pre-grazing occasion. The technique that we applied in this research, by using electronic capacitance probe can follow the temporal dynamics in a number of fixed locations in a pasture with relatively small amount of labor. It could also quantify well the spatial heterogeneity in herbage mass and the stability of spatial pattern of herbage mass (HIRATA, 2000).

2.3 Data analysis

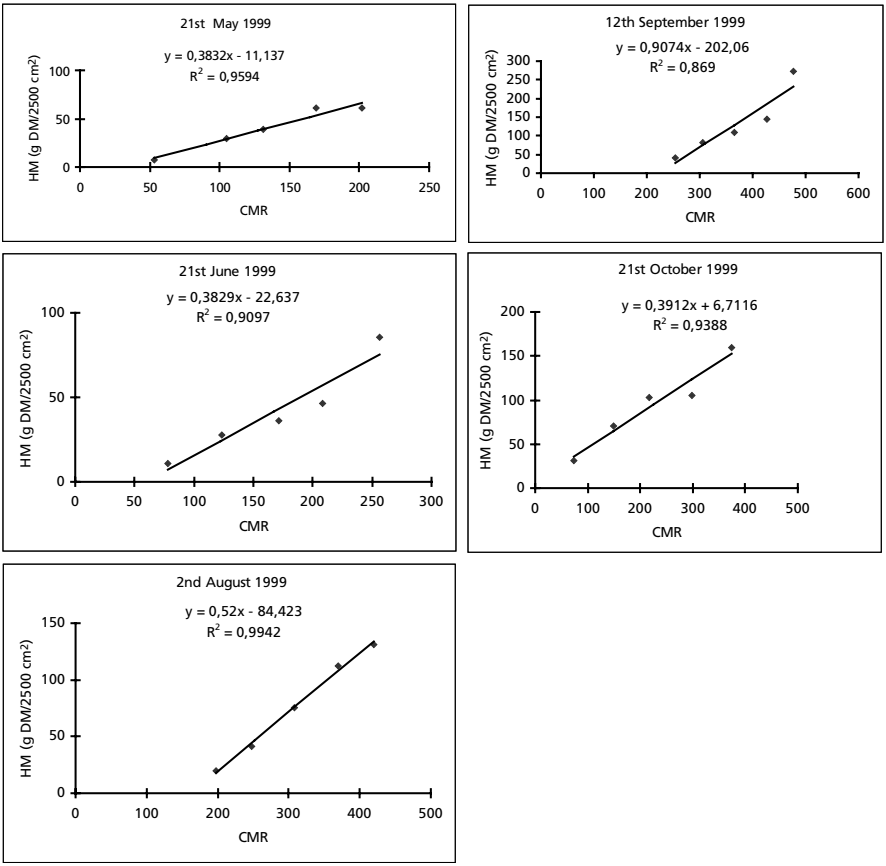
Statistical parameters: minimum, mean, maximum, standard deviation (SD) and coefficient of variation (CV) of herbage mass were calculated to show the distribution of pre-grazing herbage mass (gDM$(2500\text{cm}^2)^{-1}$) in the five years period from 1995 to 1999 on two transects.

To quantify the stability of spatial pattern of herbage mass the change in the spatial pattern between 2 measurement dates was expressed as a correlation coefficient between dates. There were 27 measurement dates, thus the correlation coefficient was calculated by comparing the HM of each date with that of 26 other dates, thus 351 calculations ($_{27}C_2$).

3 Results and Discussion

The relationship between herbage mass and CMR was each time highly significant ($p < 0.001$). Some examples (pre-grazing occasions in 1999) of the relationship between the herbage mass and CMR are shown in Figure 1. The example of pre-grazing horizontal distribution of herbage mass on both transects in 1997 is shown in Figure 2, while the following statistical parameters for each grazing season (1995-1999): minimum, mean, maximum, standard deviation (SD) are shown in Figure 3.

Figure 1: Relationships between herbage mass and corrected meter reading (CMR) by an electronic capacitance probe in 1999 (example).

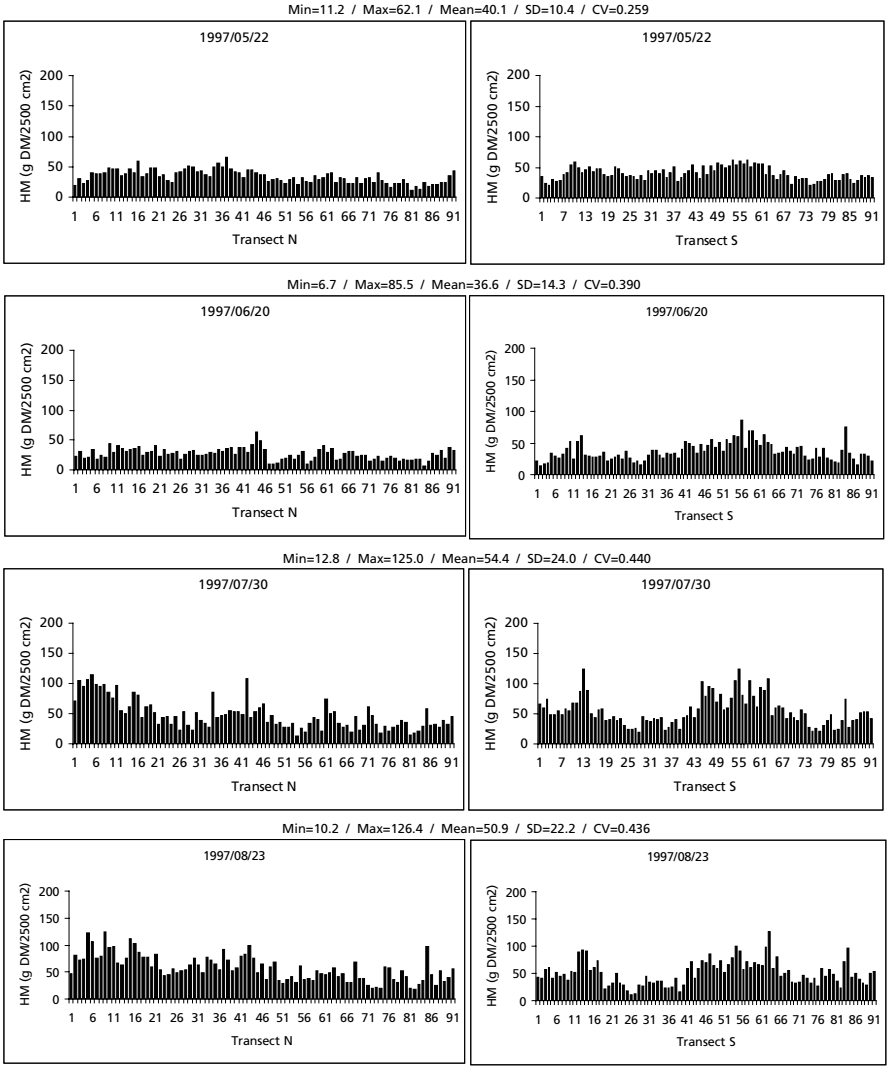


In the same figure we can see the change in these parameters for each year as follows: The HM minimum in 1995 varied from 0.0 (September/October) to13.8 (May); in 1996 from 5.0 (May) to 49.0 (September); in 1997 from 0.0 (October) to 12.8 (July); in 1998 from 12.7 (September) to 86.0 (August) and in 1999 from 12.2 (June) to 81.8 (October).

The HM maximum varied in 1995 from 36.2 (October) to 132.9 (June); in 1996 from 41.5 (June) to 193.0 (September); in 1997 from 62.1 (May) to 155.0 (October); in 1998 from 78.8 (May) to 248.0 (August) and in 1999 from 62.1 (May) to 349.4 (October).

The HM means varied in 1995 from 7.9 (October) to 45.9 (May); in 1996 from 17.2 (May) to 107.2 (September): in 1997 from 31.8 (October) to 54.4 (July); in 1998 from 54.9 (May) to 165.5 (September) and in 1999 from 31.3 (May) to 233.6 (October).

Figure 2: Pre-grazing horizontal distribution of herbage mass on two transects in 1997 ($gDM(2500cm^2)^{-1}$) (example).



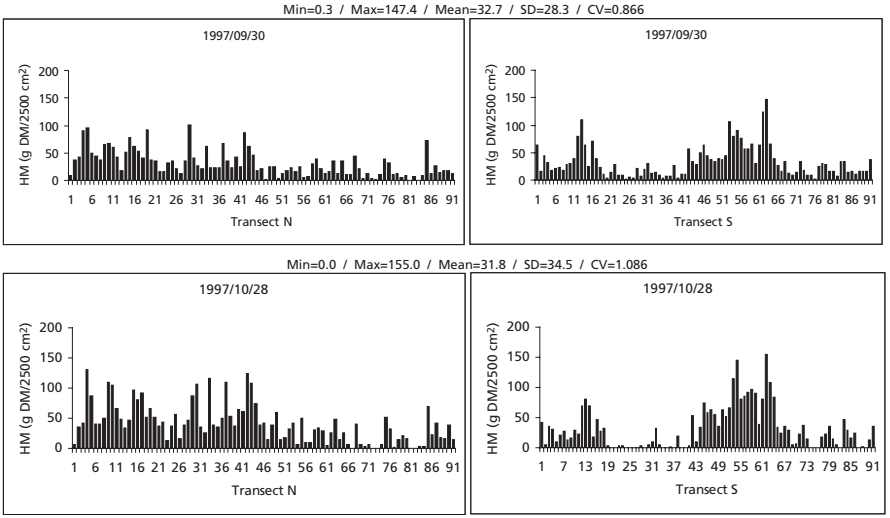
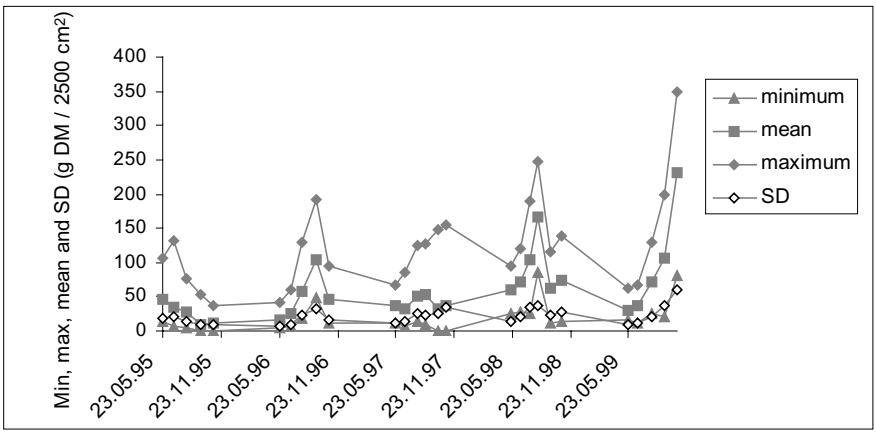


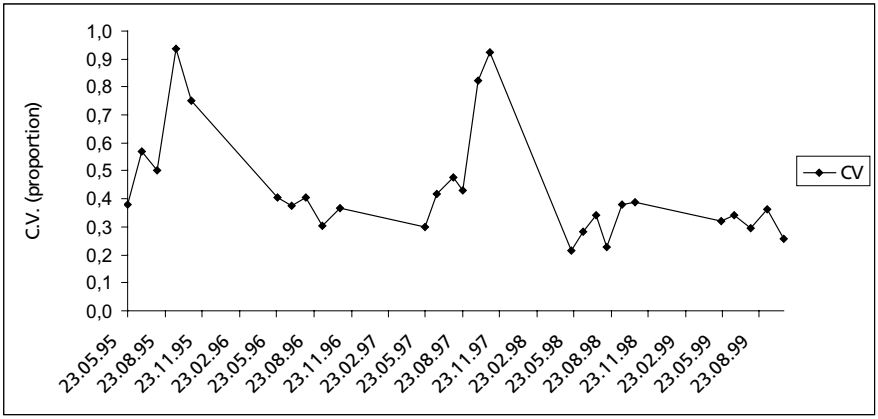
Figure 3: Statistical parameters of distribution for each grazing season (1995-1999): minimum, mean, maximum and standard deviation (SD), ($gDM(2500cm^2)^{-1}$)



The HM standard deviation varied in 1995 from 8.2 (October) to 21.5 (June); in 1996 from 7.0 (May) to 34.4 (September); in 1997 from 14.3 (June) to 34.5 (October); in 1998 from 12.2 (May) to 36.5 (August) and in 1999 from 11.0 (May) to 58.8 (October).

The coefficient of variation (CV) is shown in Figure 4. It varied in 1995 from 0.382 (May) to 1.107 (September); in 1996 from 0.321 (September) to 0.408 (May); in 1997 from 0.259 (May) to 1.086 (October); in 1998 from 0.221 (August) to 0.411 (October) and in 1999 from 0.252 (October) to 0.415 (September).

Figure 4: Coefficient of variation (CV, proportion) for each grazing season (1995-1999).



The pre-grazing herbage mass shows spatially heterogeneous distribution, as it was indicated by the coefficient of variation in the range from 0.221 (August 1998) to 1.107 (September 1995) for all measurement dates. This heterogeneity could affect livestock production through its influence on the amount of feed available, the acceptability of that feed and its digestibility and nutrient content, each of which would show varying degrees of spatiotemporal variation (Tainton *et al.*, 1996).

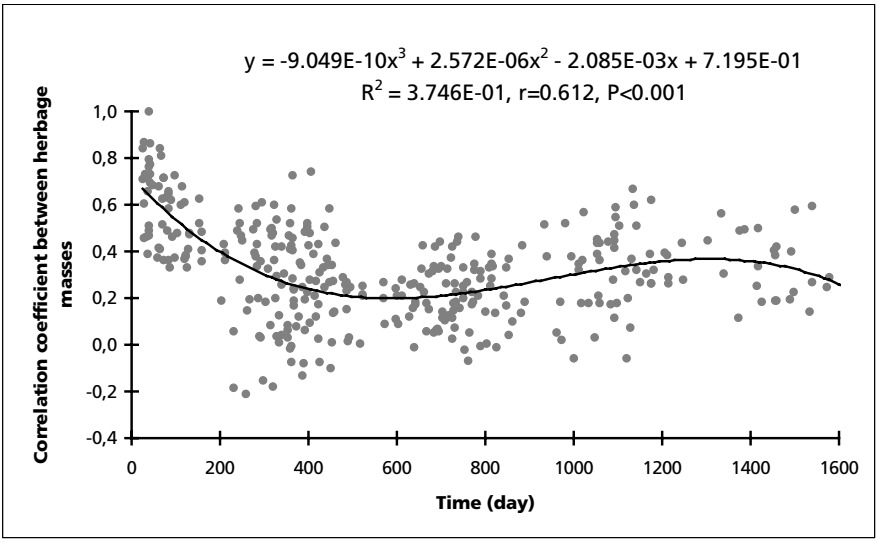
It was suggested by Edwards *et al.* (1996) that the response of plants to selective (spatially heterogeneous) grazing is a crucial factor in the development and maintenance of spatial pattern in grasslands. This is especially interesting in uniformly palatable vegetation as it was the investigated bahiagrass pasture. Experimental results on relative preferences or preference rankings reveal that herbivores show a very consistent attraction for certain plant species compared to other (Maćešić, 1995; Maćešić and Knežević, 1997; Dumont, 1997). In grasslands reach with different grass species (or grass-legume mixtures), their palatability could be the main reason for developing heterogeneity of herbage mass in a sword. But in homogeneous and palatable uniform bahiagrass pasture spatially heterogeneous grazing was the main factor, which influenced mosaic in horizontal distribution of herbage, mass. This confirms research by Bakker *et al.* (1983) who found that in also uniform *Holcus lanatus* community micro-patterns apparently developed due to random grazing.

Morris *et al.* (1999) found that structural heterogeneity was carried over to the next growing season and, with time, grazing became increasingly focussed on the short patches while tall areas were left to grow out, thereby enhancing the patch structure of the sward. The same pattern appeared to happen in bahiagrass pasture in this study. Hirata (1998) explained that the stability pattern in herbage mass is fundamentally determined by the foraging behaviour of animals and growth characteristics of plants. Therefore, grazing causes a decline in biomass but an increase in nutritive value through the stimulation of regrowth (McNaughton, 1984; Hirata, 1996).

Although the bahiagrass pasture in this experiment was rotationally grazed for five years it still maintains good stability trending to increase the herbage mass mean toward the middle of a grazing season (August/September 1996, July/August 1997, July/August 1998) or even toward the end of a grazing season (September/October 1999).

This research had also the aim to quantify the stability of sward in a long-term distribution of pre-grazing herbage mass in bahiagrass pasture, utilised under the same repeated grazing management, as it has shown in Figure 5. Each point on the graph represents correlation coefficient between two measurements dates plotted against the time differences between those dates. In previous paper HIRATA (1998) applied linear regression equation that showed that the correlation coefficient decreases as the interval between the pre-grazing measurements increases and the data sets scattered considerably around the regression line. However, that research was limited on 2.5 year available data set at that time, and it could lead to the conclusion that a negative trend in maintenance of spatial pattern of pre-grazing herbage mass is to be expected in the future. That too, can also be the example why short term experiments may give misleading results and there is the need for trials to document the long-term effect of treatments on pasture.

Figure 5: Correlation coefficient of a herbage mass on two measurements dates plotted against the time between the dates.



The correlation coefficient of multilinear regression (r=0.612) that is shown in Figure 5 is highly significant ($p < 0.001$). The multilinear regression equation shows that the correlation coefficient decreases as the interval between the pre-grazing measurements increases, reaching the lowest point after 570 days (r=0.198). After that moment, the multilinear regression curve is rising again until the peak point at 1210 days (r=0.382) from the beginning of the experiment, or 640 days after reaching the lowest point. Furthermore, the trend curve tend to decrease again reaching the lowest point in the

last measurement at 1577 days (r=0.248) after the beginning of the experiment, or 367 days after the last peak. The individual data sets indicated that the spatial pattern of vegetation in bahiagrass pasture is approximately in a range of 600 days (highest point-lowest point interval). This is based on five years pre-grazing data set in bahiagrass pasture, but it is difficult to say weather this pasture is going to maintain the same spatial pattern of herbage mass in, for example, next five years. That is, to continue this research in the future is necessary task in obtaining more information about spatial heterogeneity of vegetation in bahiagrass pasture, and implication of agro ecological advantages to grazing systems.

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References

Bakker, J. P., de Leeuw, J. and van Wieren, S. E.; Micro-pattern in grassland vegetation created and sustained by sheep-grazing; *Vegetatio*; 55:153–161; 1983.

Dumont, B.; Diet preferences of herbivores at pasture; *Ann Zootech*; 46:105–116; 1997.

Edwards, G. R., Parsons, A. J., Newman, J. and Wright, I. A.; The spatial pattern of vegetation in cut and grazed grass/white clover pastures; *Grass and Forage Science*; 51:219–231; 1996.

Gordon, I. J. and Illius, A. W.; Foraging strategies of sheep and goats: from monoculture to mosaic; in: *Progress in Sheep and Goat Research*, edited by Speedy, A. W.; pages 153–178; CAB International, Wallingford; 1992.

Hirata, M.; A new technique to describe canopy characteristics of grass swards with spatial distribution, dry matter digestibility and dry weight of small-size canopy components; *Grass and Forage Science*; 51:209–218; 1996.

Hirata, M.; Dynamics in the horizontal distribution of herbage mass in a Bahiagrass (*Paspalum notatum* Flügge) pasture grazed by cattle: Stability of spatial pattern of herbage mass; *Grassland Science*; 44(2):169–172; 1998.

Hirata, M.; Quantifying spatial heterogeneity in herbage mass and consumption in pastures; *Journal of Rangeland Management*; 53:315–321; 2000.

Hirata, M. and Fukuyama, K.; Dynamics of the horizontal distribution of herbage mass in a Bahiagrass (*Paspalum notatum* Flügge) pasture with grazing by cattle; *Grassland Science*; 43(1):1–6; 1997.

Illius, A. W. and Hodgson, J.; *The ecology and management of grazing systems*; chap. Progress in understanding the ecology and management of grazing systems, pages 429–459; CAB International, Wallingford; 1996.

Maćešić; Procjena intenziviranosti pašnjaka korištenjem pašcnoga vremena; *ACS - Agriculturae Conspectus Scientificus*; 60(3-4):307–318; 1995.

Maćešić, D. and Knežević, M.; Behaviour of cattle on two different types of upland pastures; Proccedings of the 18th International Grassland Congress, 8-19 June 1997,

Winnipeg, Saskatoon, Canada, p. 5-21/22; 1997.

McNaughton, S. J.; Grazing lawns: animals in herds, plant and co-evolution; *American Naturalist*; 124:863–886; 1984.

Morris, C. D., Derry, J. F. and Hardy, M. B.; Effect of cattle and sheep grazing on the structure of Highland Sourveld swards in South Africa; *Tropical Grasslands*; 33:111–121; 1999.

Pakiding, W. and Hirata, M.; Tillering in bahia grass (*Paspalum notatum*) pasture under cattle grazing: results from the first two years; *Tropical Grasslands*; 33(3):170–176; 1999.

Tainton, N. M., Morris, C. D. and Hardy, M. B.; Complexity and stability in grazing systems; in: *The ecology and management of grazing systems*, edited by Hodgson, J. and Illius, A. W.; pages 275–301; CAB International, Wallingford; 1996.

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Factors Influencing Adoption of Soil Conservation Measures in Southern Ethiopia: The Case of Gununo Area

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Abstract

Soil degradation is one of the most serious environmental problems in Ethiopia. The Ethiopian highlands have been experiencing declining soil fertility and severe soil erosion due to intensive farming on steep and fragile lands and other factors attributed to population pressure. This study used a binomial logit model to identify factors that determine adoption of physical soil conservation measures, namely soil bunds and *fanyajuu* in Southern Ethiopia, Gununo area. Data collected from a random sample of 120 heads of households were used to estimate the binomial logit model. The results show that adoption of soil conservation measures depends on a host of factors. About 78 percent of the sample cases were correctly predicted using the model.

Keywords: adoption, binomial logit model; soil conservation measures, soil erosion

1 Introduction

Ethiopia is one of the largest countries in Africa both in terms of land area (1.1 million km^2) and population (70.7 million). With a per capita GNP of 100 dollars in 2001, Ethiopia is one of the poorest countries in the world (World Bank, 2003). The Ethiopian economy is based mainly on agriculture which provides employment for 85 percent of the labor force and accounts for a little over 50 percent of the GDP and about 90 percent of export revenue. However, low productivity characterizes Ethiopian agriculture. The low productivity of the agricultural sector has made it difficult to attain food self-sufficiency at a national level.

Natural resource degradation is the main environmental problem in Ethiopia. The degradation mainly manifests itself in terms of lands where the soil has either been eroded away and/or whose nutrients have been taken out to exhaustion without any replenishment, deforestation and depletion of ground and surface water. The majority of the farmers in rural areas of Ethiopia are subsistence-oriented, cultivating impoverished soils on sloppy and marginal lands that are generally highly susceptible to soil erosion and other degrading forces. Soil erosion is a phenomenon, which mainly occurs in the highlands of Ethiopia (areas $>$ 1500 meters above sea level) which constitute about 46 percent of the total area of the country, support more than 80 percent of the population,

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and account for over 95 percent of the regularly cultivated land and about 75 percent of the livestock population (SHIFERAW and HOLDEN, 1998). Erosion is most severe on cultivated lands, averaging 42 metric tons (MT) per hectare per year on currently cultivated lands and 70 MT per hectare per year on formerly cultivated degraded lands (HURNI, 1988). According to GIRMA (2001), Ethiopia loses annually 1.5 billion MT of topsoil from the highlands by erosion. This could have added about 1 to1.5 million MT of grain to the country's harvest. A study by SHIFERAW and HOLDEN (1998) shows that the problem of soil erosion is compounded by the fact that some farmers dismantled the conservation structures built in the past through food for work incentives. In fact, until the early 1990s farmers were not allowed to remove the conservation structures once built on their land. However, the introduction of economic reform program in 1990 and subsequent liberalization of the economy also brought more freedom and hence conservation structures could be removed if the land user so wishes.

A review of the relevant literature points to the fact that a number of empirical studies have been undertaken on technology adoption under Ethiopian context. However, nearly all of them have been addressing issues of adoption in relation to improved production technologies. Available evidence shows that studies on the determinants of adoption of soil conservation measures are few and far between. Therefore, this study was conducted in view of bridging this gap. The objectives of this paper are to identify socioeconomic, demographic, institutional and biophysical factors factors, which influence adoption of physical soil conservation measures in Gununo area (Southern highlands of Ethiopia). The rest of this paper is organized in three sections. Section II deals with the research design and methods of data collection and analysis. Section III discusses the findings of the study. The final section summarizes the findings and discusses their policy implications.

2 Research design and analytical method

2.1 Description of the study area

The study area, Gununo, is located in Kindo-Koysha district of Wolaita Zone, the Southern Nations, Nationalities and Peoples Regional State[3]. More specifically, it is located in Doge-Shakisho peasant association, which is found in the southern part of the Ethiopian highlands. The altitude of the study area ranges from 1980 to 2100 meters above sea level. The study area covers 1,006 hectares with an average population density of 523 persons per km^2. Agriculture is the principal economic activity in the study area, though some people derive additional income from basketry, pottery and local beverages. Agricultural production is destined mainly for home consumption. The principal agricultural activity is crop cultivation, which is entirely rain-fed with livestock

[3] With the change in government in 1991, on the basis of ethnic, linguistic and cultural identity, the country was divided into 9 semi-autonomous regional states, one federal capital (Addis Ababa) and one special administrative division (Dire Dawa). According to the Ethiopian Federal Democratic Republic administrative hierarchy, the regional states are divided into zones, districts and *kebeles* in urban areas or peasant associations in rural areas (local administration units), in that order.

rearing as a secondary activity. Almost every farmer practices two cropping systems on his/her cultivated land -a garden system and a field cropping system. In the gardens, farmers plant enset (a staple food of the area)[4], coffee and cabbage. Farmers plant on their fields seasonal crops, such as maize, haricot beans, sorghum, barley and teff (*Eragrostis tef*). Among root crops, sweet potato, Irish potato, taro, cassava and yam are important in the area.

Gununo area is characterized by unimodal rainfall regime with extended rainy season from March to October, although the other months have little to moderate amount of rainfall. Over the 1981-1987 period, the average annual rainfall was 1335 mm and the mean maximum temperature was about 23°C, while the minimum temperature ranged between 15°C and 18°C (SCRP, 1988). Undulating slopes divided by V-shaped valleys of seasonal and/or relatively permanent streams characterize the topography of the study area. Very steep slopes are found along the valley sides, where slopes greater than 30% are very common.

The data for this study were collected from six villages located in the Gununo area. The study covered a total area of 269 hectares with 329 households at the time of the survey (September 2000). The Gununo catchment, which consists of four villages namely Fatata, First Shega, Second Shega and Second Shakisho, was one of the seven national research stations of the Soil Conservation Research Program (SCRP). The SCRP was implemented jointly by the Ethiopian Ministry of Agriculture and the Center for Development and Environment of the University of Berne (Switzerland), in the period 1982-1993. In the course of its implementation, the SCRP introduced and popularized two types of physical soil conservation measures, namely soil bunds and *fanyajuu* in the Gununo area. These structures consist of narrow ridges and canals at slight angle to the contour in order to control erosion and facilitate terrace development. *Fanyajuu* is a terracing process whereby a trench is excavated to form an embarkment on the upper side by throwing the excavated soil uphill whereas soil bunds are constructed by digging a ditch and throwing the soil downhill.

As part of its strategy to popularize soil conservation measures in the Gununo area, the SCRP constructed, free of charge, soil bunds and/or *fanyajuu* on the fields of 220 households (first on the fields of 93 households located in the Gununo catchment and at a later stage on the fields of 127 households located in Buralessa and Gedalla villages, which are adjacent to the catchment) with the belief that these structures would have multiplier effects on the farmers in close proximity to the catchment by way of demonstration and as a result of social interaction. For the purpose of this study the Gununo area was divided into two sites: one with soil conservation structures constructed on farmers' fields by SCRP and another one where there was no direct intervention by SCRP. The former covers an area of 174 ha (74 ha in the Gununo catchment and 100 ha in villages adjacent to the catchment), while the latter covers an area of 95 ha (consisting of Second Shakisho and Second Shega villages located in the Gununo catchment).

[4] Enset (*Ensete ventricosum*) is a banana-like perennial plant grown throughout the Southern Highlands of Ethiopia as the major staple food crop by many cultural groups

2.2 Sampling design

As already noted, the study area was divided in to two sites, one with soil conservation structures constructed on farmers' fields by SCRP (treated site[5]) and another one where there was no direct intervention by SCRP (non-treated site). The treated site consists of four villages, namely Fatata, First Shega, Buralessa and Gedalla while the non-treated site consists of two villages, namely Second Shakisho and Second Shega. In the early 1980s, soil bunds and *fanyajuu* were introduced in Fatata and First Shega villages. More precisely, the SCRP constructed the structures on the fields of the 93 households residing in the two villages. In 1987, following the request made by the farmers in Burallessa and Gedalla villages, the SCRP constructed soil bunds and fanyajuu on the fields of 127 households through the food-for-work scheme.

The survey covered 120 household heads (80 from the treated site and 40 from non-treated site) randomly selected from six villages stratified to include representative samples of areas with (four villages) and without (two villages) direct intervention from SCRP (Table 1). With regard to the sampling technique, proportional random sampling technique was used to select sample respondents from each village.

Table 1: Distribution of sample respondents by villages and farmer group

Site	*Village*	*Total number of households*	*Sampled households*					
			Adopters		*Non-adopters*		*Total*	
			N	*% of total sample*	*N*	*% of total sample*	*N*	*% of total sample*
Treated	Fatata	60	21	17.5	1	0.8	22	18.3
	1st Shega	33	6	5.0	6	5.0	12	10.0
	Buralessa	58	12	10.0	9	7.5	21	17.5
	Gedalla	69	12	10.0	13	10.8	25	20.8
Sub-total		220	51	42.5	29	24.2	80	66.6
Non-treated	2nd Shega	55	6	5.0	14	11.7	20	16.7
	2nd Shakisho	54	4	3.3	16	13.3	20	16.7
Sub-total		109	10	8.3	30	25.0	40	33.4
Grand Total		329	61	50.8	59	49.2	120	100

Although most of the adopters were from villages located in the treated site, there were adopters in villages located in the non-treated site. On the other hand, there were non-adopters even within villages located in the treated site[6]. It should be noted that of the 80 sample respondents selected from the treated site those farmers, who retained the

[5] A treated site is a site where SCP constructed soil conservation structures on farmers' fields.

[6] Adopters were defined as farmers who had either soil bunds or *fanyajuu* or both in at least one plot of their farms at the time of the survey.

introduced technology, either totally or partially, were considered as adopters; whereas those who removed the structures totally were considered as non-adopters. More precisely, of the 80 sample respondents selected from the treated site, 51 were considered as adopters (18 retained the soil conservation structures built on their fields and 33 removed the structures partially) and the remaining 29 farmers were considered as non-adopters (they removed all the structures built on their fields). Similarly, of the 40 sample respondents selected form the non-treated site, 10 adopted the physical soil conservation measures, while the remaining 30 did not adopt the measures.

2.3 Method of data collection

Field research was conducted from September to December 2000. A structured questionnaire was used for the field interviews. The questionnaire was pre-tested by administering it to selected respondents. On the basis of the results obtained from the pretest, necessary modifications were made on the questionnaire. Five technical assistants and two researchers administered the structured questionnaire. In addition to the questionnaire survey, discussions were made with key informants including community leaders, development workers and representatives of non-governmental organizations. Moreover, group discussions were made with randomly selected farmers. These informal techniques helped to acquire useful and detailed information, which would have been difficult to collect through the questionnaire survey.

2.4 Analytical approach

Farmers' decision to adopt or reject new technologies at any time is influenced by a complex set of socioeconomic, demographic, institutional and biophysical factors. Modeling farmers response to agricultural innovations has, therefore, become important both theoretically and empirically. Analysis of the relationship between adoption and determinants of adoption involves a mixed set of qualitative and quantitative data. The response (dependent) variable is dichotomous taking on two values, 1 if the event occurs and 0 if it does not. Estimation of this type of relationship requires the use of qualitative response models. In this regard, the linear probability models, logit and probit models are the possible alternatives. Both the logit and probit models yield similar parameter estimates and it is difficult to distinguish them statistically (Aldrich and Nelson, 1990). However, Maddala (1983) and Gujarati (1988) reported that the logistic and cumulative normal functions are very close in the mid-range, but the logistic function has slightly heavier tails than the cumulative normal function; that is, the normal curve approaches the axes more quickly than the logistic curve. Because of the fact that the binomial logit model is easier to estimate and simpler to interpret, it is used in the present study.

2.5 Working hypotheses and variable specification

Farmers' decision to adopt new technologies at any time is influenced by the combined effect of socioeconomic, demographic, institutional and biophysical factors, which are

related to their objectives and constraints. In this section, the variables to be used in the binomial logit model and the associated working hypotheses are presented.

The dichotomous dependent variable for the adoption model, CNSRV, indicates whether or not a household uses soil conservation measures. CNSRV=1, for households that had either soil bunds, or *fanyajuu* or both in at least one plot of their farms at the time of the survey (adopters) and CNSRV=0 for households that had no soil conservation structures on their fields at the time of the survey (non-adopters). The independent variables of the study are those which are hypothesized to have association with the dissemination and adoption of soil conservation measures. More specifically, the findings of various empirical studies on the adoption of soil conservation measures, the existing theoretical explanations, and the authors' knowledge of the farming systems of the study area were used to select 15 explanatory variables and structure the working hypotheses. The potential explanatory variables, which are hypothesized to influence the adoption of physical soil conservation measures in the study area are presented in Table 2.

3 Results and Discussion

In this section the results of the survey and analytical findings are presented and discussed.

3.1 Descriptive results

As noted earlier, a sample of 120 households consisting of 61 (51%) adopters and 59 (49%) non-adopters was selected from six villages located in Gununo Catchment. About 90 percent of the household heads were males. The survey results show that adopters and non-adopters differ in various aspects. On average, the adopters were relatively younger (42.4 years) than the non-adopters (43.1 years). The non-adopters had slightly larger family size (7.1 persons) than the adopters (6.8 persons). On average each household in the adopter group had 4.5 adult members (active agricultural workers in the age bracket of 15-65 years), while the corresponding figure for the non-adopter group was 3.8. Adopters of soil conservation measures had an average of 1.74 years of formal schooling. The corresponding figure for the non-adopters was 2.25 years. The average size of farmland owned by the sample respondents was 0.8 ha. Adopters owned, on average, relatively larger farm size (0.88 ha) than the non-adopters (0.73 ha). Furthermore, the adopters kept, on average, more livestock (1.8 TLU) than the non-adopters (1.6 TLU). The average land to man ratio for the sample respondents was found to be 0.11 (0.11 for the adopters and 0.12 for the non-adopters). This very low land to man ratio indicates that the area is overpopulated. Therefore, soil conservation technologies, which take some land out of production, like construction of soil conservation structures, have little chance of acceptance by farmers in the study area.

About 59 percent of the respondents reported that their farmlands were susceptible to erosion. Similarly, about 77 percent of the respondents perceived soil erosion as a problem. With regard to security of land ownership right, about 90 percent of the respondents indicated that they felt secure to use their farmland at least in their lifetime.

Table 2: Summary of the Variables used in the logistic regression model.

Explanatory variables	*Unit or type*	*Expected relationship*	*Empirical studies supporting the expected relationship*
AGEF	Age of the household head in years	negative	Gould *et al.* (1989); Sureshwaran *et al.* (1996); Yohannes (1992); Shiferaw and Holden (1998)
FAMILYSZ	The total number of members in a family.	negative	Shiferaw and Holden (1998)
ASSIST	Dummy, 1 if the farmer gets assistance from governmental or non-governmental organization to adopt soil conservation measures; 0 otherwise	positive	Ervin and Ervin (1982); Norris and Batie (1987); Sureshwaran *et al.* (1996); Pattanayak and Mercer (1998)
EDUC	Schooling years of the household head	positive	Ervin and Ervin (1982); Yohannes (1992); Pender and Kerr (1996); Sureshwaran *et al.* (1996)
FARMSZ	Total area of the farm land (cultivated, grazing, homestead and forest) in hectare.	positive/ negative	Ervin and Ervin (1982); Norris and Batie (1987); Gould *et al.* (1989); Sureshwaran *et al.* (1996); Shiferaw and Holden (1998); Mbaga-Semgalawe and Folmer (2000); Boserup (1965)
LANDSECU	Dummy, 1 if the farmer feels that the land belongs to him/her at least in his/her lifetime; 0 otherwise.	positive	Ervin and Ervin (1982); Norris and Batie (1987); Yohannes (1992); Girma (2001); Mulugeta *et al.* (2001)
LANMAN	The ratio of farm size to family size	negative	Shiferaw and Holden (1998); Lapar and Pandey (1999)
INDEPNDT	The number of economically active family members in the household	positive	Pender and Kerr (1996); Sureshwaran *et al.* (1996)
GROUP	Dummy, 1 if the household has a plot in the SCRP catchment; 0 if the household has its land in Buralessa and Gedalla villages.	positive	Mulugeta *et al.* (2001)
PERCEPTN	Dummy, 1 if erosion problem is perceived as a serious problem; 0 otherwise.	positive	Ervin and Ervin (1982); Shiferaw and Holden (1998)
SLOPE	Dummy, 1 if the farmland is steep or very steep; 0 otherwise.	positive	Ervin and Ervin (1982); Norris and Batie (1987); Gould *et al.* (1989); Pattanayak and Mercer (1998); Lapar and Pandey (1999)
TECHATTR	Dummy, for technology characteristics: 1 if farmers express physical soil conservation measures as a source of rodents, running grasses and pose difficulty in plowing; 0 otherwise.	negative	Yohannes (1992); Shiferaw and Holden (1998)
LIVSTOWN	Livestock holdings of the household head in Tropical Livestock Unit (TLU)*.	positive	Shiferaw and Holden (1998)
TYHOUSE	Dummy, 1 if the farmer has corrugated iron roof house; 0 otherwise.	positive	Shiferaw and Holden (1998); Mulugeta *et al.* (2001)
OFFINCOM	Dummy, 1 if the farmer earns off-farm income; 0 otherwise.	positive/ negative	Ervin and Ervin (1982); Clay *et al.* (1998); Mbaga-Semgalawe and Folmer (2000)

* One Tropical Livestock Unit (TLU) is equal to 250 kg which is equivalent to 1 camel; 0.7 cattle; 0.8 horse/mule; 0.5 donkey; 0.1 goat/sheep (ILCA, 1992).

This high percentage could be attributed to the fact that there was no land redistribution in the study area. The majority of the respondents (about 55%) reported that the physical soil conservation structures have inherent problems (the structures being considered as breeding ground for rodents, expansion of grass towards the farm land and posing difficulty in plowing across the field). Sixty-one percent of the respondents indicated that they earned additional income from non-farm activities. Eighteen percent of the sample respondents owned corrugated iron-roofed houses whereas the rest (82 %) owned thatched houses.

Farmers' decision to adopt soil conservation measures is not only influenced by their perception of erosion hazard but also by the types of structures and their attributes. As already noted, of the 80 sample respondents in the treated site, 33 removed the structures partially and 29 removed them totally. The sample respondents who removed the soil conservation structures partially or totally were asked to list down the reasons for their decision and their responses are set out in Table 3. About 55 percent of the sample farmers who removed soil conservation structures partially and about 59 percent of the respondents who removed the structures totally reported that mole rat, running grass and difficulty of plowing across the field were the main reasons for removing the soil conservation structures. Other important reasons for removing structures partially or totally include, the belief that the farmland was relatively flat, the potential loss of land to conservation structures, which occupy part of the scarce productive land, and proximity of the plot, from which the structures were removed, to *enset* field. This is because *enset* plant is believed to help control soil erosion.

Table 3: Distribution of sample farmers from the treated site by their reasons for removing soil conservation structures partially or totally

Reasons	*Removed partially*		*Removed totally*	
	N	*%*	*N*	*%*
Technology attributes[1]	18	54.5	17	58.6
Slope of the farm land was not steep	3	9.1	6	20.7
Shortage of the farm land and technology attributes	7	21.2	0	0
Shortage of land[2]	3	9.1	4	13.8
Plot not far from enset field	1	3.0	1	3.4
Shortage of land and moderate slope of the plot	1	3.0	0	0
Fear of conflicts with neighbors	0	0	1	3.4
Total	33	100	29	100

[1] structures were source of rodents and running grass and increased labor time for land preparation

[2] structures put considerable amount of land out of production

The survey results reveal also the reasons why the majority of the sample farmers in the non-treated site (75 percent) did not adopt physical soil conservation measures (Table 4). Responses from non-adopters in the non-treated site about the reasons for not adopting physical soil conservation measures indicate that loss of cultivable land to conservation structures was the most commonly cited major reason (about 27%) (Table 4). The inherent problems associated with the soil conservation structures, such as becoming sources of rodents and running grass and increasing labor time for land preparation were considered to be the major reasons for non-adoption by about 23 percent of the non-adopters in the non-treated site. Other reasons cited for not adopting physical soil conservation measures include, preference given to indigenous soil conservation measures (13.3%), the perception that soil erosion was not a problem because of the moderate slope of the farmland (10%), lack of government assistance (10%), labor shortage (10%) and relatively high labor requirements to establish and maintain the structures (7%)[7].

Table 4: Farmers' reasons for the non-adoption of physical soil conservation measures in the non-treated site

Reasons	*Number of farmers*	*Percent*
Structures take some land out of production	8	26.7
Structures are sources rodents, running grass and create difficulty in plowing	7	23.3
Prefer indigenous soil conservation measures	4	13.3
The slope of the farm land was not steep	3	10.0
Lack of government assistance	3	10.0
Labor shortage	3	10.0
High cost of labor for establishment and maintenance of structures	2	7.0
Total	30	100

3.2 Analytical findings

The maximum likelihood method of estimation was used to elicit the parameter estimates of the binomial logistic regression model and statistically significant variables were identified in order to measure their relative importance on the farmers' soil conservation

[7] The indigenous soil conservation practices that were reportedly used in the study area include planting of banana, *enset*, crop-residue/trash line, and construction of water-way.

adoption decision. The binomial logistic regression required six iterations to generate the parameter estimates[8].

The value of Pearson - χ^2 indicates the goodness-of-fit test for the fitted model. The likelihood ratio test statistic exceeds the χ^2 critical value with 15 degrees of freedom at less than 1 % probability level, indicating that the hypothesis that all the coefficients, except the intercept are equal to zero is rejected. Another measure of goodness of fit is based on a scheme that classifies the predicted value of the dependent variable, CNSRV, as 1 if $P_{(i)} \geq 0.5$ and 0 otherwise. The model correctly predicts 94 of 120 (78.3 percent) observations. The sensitivity (correctly predicted adopters) and the specificity (correctly predicted non-adopters) of the binomial logit model are 78.7 percent and 78 percent, respectively. Thus, the model predicts both groups, the adopters and the non-adopters, fairly accurately.

The maximum likelihood estimates for the binomial logit model are set out in Table 5. The model results indicate that the signs of all the variables, except that of TECHATTR and TYHOUSE, turned out to be consistent with the a priori expectations. Out of the fifteen variables hypothesized to influence the adoption of physical soil conservation measures, four were found to be significant at less than one percent probability level. These include the number of economically active family members (INDEPNDT), whether or not a household has a plot within the SCRP catchment (GROUP), perception of soil erosion problem (PERCEPTN) and attributes of soil conservation structures (TECHATTR). Three variables were significant at five percent probability level. These variables include family size (FAMILYSZ), farm size (FARMSZ) and the type of house (TYHOUSE). Eight of the fifteen explanatory variables that were hypothesised to affect adoption of physical soil conservation measures did not have statistically significant effects.

The estimated binomial logit model shows that family size (FAMILYSZ) affects the adoption of physical soil conservation measures negatively and significantly. This result is consistent with the *a priori* expectation. This is so because households with larger family size are likely to face food shortage in periods of drought. As a result, they try to maximize short-term benefits and would be less interested in soil conservation measures whose benefits can be reaped in the long run.

As expected, farm size (FARMSZ) has a positive and significant influence on the farmers' decision to adopt physical soil conservation measures. The possible explanation is that larger farms are associated with greater wealth and increased availability of capital, which increase the probability of investment in soil conservation measures. Adoption of soil conservation measures is significantly and positively associated with the number of economically active family members (INDEPNDT). The implication is that house-

[8] A technique called variance inflation factor (VIF) was used to measure the degree of linear relationships among the quantitative explanatory variables. Moreover, contingency coefficients were computed for each pair of qualitative variables to check for the degree of association among the qualitative variables. As the results show very small degree of collinearity among the explanatory variables, all of the qualitative and quantitative variables were included in the estimation of the model.

Table 5: The Maximum Likelihood Estimates of the binomial logit model.

Variable name	*Estimated Coefficient*	*Odds Ratio*	*Wald Statistics*	*Significance Level*
Constant	-5.173	0.01	8.014	0.005 ***
AGEF	-0.010	0.99	0.253	0.615
FAMILYSZ	-0.424	0.65	5.113	0.024 **
ASSIST	0.637	1.89	1.435	0.231
EDUC	-0.117	0.89	1.9322	0.165
FARMSZ	2.596	13.40	4.398	0.036 **
LANDSECU	0.729	2.07	0.804	0.37
LANMAN	-8.014	000	2.025	0.155
INDEPNDT	0.698	2.01	8.559	0.003 ***
GROUP	2.189	8.92	13.207	0.00 ***
PERCEPTN	1.927	6.87	8.458	0.004 ***
SLOPE	0.405	1.50	0.623	0.43
TECHATTR	1.465	4.33	8.799	0.003 ***
LIVSTOWN	0.001	1.00	1.027	0.311
TYHOUSE	-1.551	0.21	4.182	0.041 **
OFFINCOM	-0.057	0.95	0.013	0.910
Pearson-χ^2		55.065 ***		
Likelihood Ratio Test		117.114 ***		
Correctly Predicted		78.3[a]		
Sensitivity		78.7[b]		
Specificity		78.0[c]		

*** Significant at less than 1% probability level;

** Significant at 5% probability level

[a] Based on a 50-50 probability classification scheme

[b] Correctly predicted adopters based on a 50-50 probability classification

[c] Correctly predicted non-adopters based on a 50-50 probability classification scheme

Source: model output

holds with large number of active agricultural workers are more likely to invest in soil conservation measures, which are known to be labor intensive. The variable GROUP, which indicates whether or not a household has a plot within the SCRP catchment, has a significant positive influence on the adoption of physical soil conservation measures.

This is precisely because those farmers who have plots with in the SCRP catchment have the possibility to meet the project staff and be well informed about the consequences of soil erosion than those who own land outside the catchment. As anticipated, farmers' perception of soil erosion problem (PERCEPTN) affects the adoption of soil conservation measures positively and significantly. The implication is that farmers who feel that their farmlands are prone to soil erosion are more likely to adopt physical soil conservation measures than those who do not perceive the problem of soil erosion.

The estimated model shows that the technology characteristics (TECHATTR) has a positive and significant influence on the adoption of physical soil conservation measures. The possible explanation may be that despite the perceived negative impacts associated with the technology, farmers adopt physical soil conservation measures. This could be explained by the fact that those farmers who had already adopted physical soil conservation measures were aware of the possible consequences of soil erosion and they retained the structures no matter how problematic they might be. It is, however, important that soil conservation technologies go hand in hand with appropriate technologies, which help mitigate the undesirable effects of the technologies in question. Contrary to the *a priori* expectation, the type of house, used as a proxy for wealth, has a significant negative influence on the adoption of physical soil conservation measures. This may be due to the fact that this variable is not a very good proxy for wealth. In fact, the informal survey results reveal that some farmers who own corrugated iron roofed houses had totally removed the soil conservation structures built by the SCRP. Similarly, some of the farmers who own corrugated iron roofed houses were categorized under the poor wealth category by the key informants, indicating that the possession of a corrugated iron roofed house is not a good indicator of the current wealth status in the study area. It is also interesting to note that, of the 22 respondents who owned corrugated iron roofed houses, thirteen reported that they received remittance from their children who settled in big urban centers and/or abroad, which in our view might make them less interested in soil conservation work.

4 Conclusion

This study attempted to identify important factors, which influence adoption of physical soil conservation measures in the Southern Highlands of Ethiopia, Gununo area. The empirical results show that the major factors influencing adoption of physical soil conservation measures in the study area are: farmers' perception of soil erosion problem; technology attributes; the number of economically active family members; farm size; family size; wealth status of the farmer; and the location of the farmland (whether or not the farmer has a plot of land inside the SCRP catchment). An important implication of the results presented in this paper is that any intervention in soil conservation should recognize the heterogeneity in household characteristics, land holding, institutional patterns and technology-specific traits.

Another implication of the findings of this study is the need to increase farmers' perception of soil erosion problem through the provision of knowledge and demonstration of gains and risk reduction characteristics of soil conservation practices. This is important

because the extent to which farmers understand and feel the need for controlling soil erosion affects adoption of soil conservation measures positively. The results also highlight the need to undertake research on indigenous soil conservation measures, which were reported to be well adapted to the study area by some of the non-adopters. It goes without saying that sustainable use of soil conservation measures critically depends on their suitability to the local ecology and the farming systems. Therefore, it is important to design soil conservation practices, which couple modern scientific knowledge with indigenous technical knowledge to facilitate their dissemination and ensure their sustainability.

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References

Aldrich, J. H. and Nelson, F. D.; *Linear Probability, Logit and Probit Models*; Sage Publications, London; 1990.

Boserup, E.; *The Conditions of Agricultural Growth: The Economics of Agrarian Change Under Population Pressure*; George Allen and Unwin Ltd, London, UK; 1965.

Clay, D., Readon, T. and Kang, A. T.; Sustainable Intensification in the Highland Tropics Rwandan farmers' Investment in Land Conservation and Soil Fertility; *Economic Development and Cultural Change*; 46(2):351–377; 1998.

Ervin, C. A. and Ervin, D. E.; Factors Affecting the Use of Soil Conservation Practices: Hypotheses, Evidence, and Policy Implications; *Land Economics*; 58(3):277–292; 1982.

Girma, T.; Land Degradation: A Challenge to Ethiopia; *Environmental Management*; 27(6):815–824; 2001.

Gould, B. W., Saupe, W. E. and Klemme, R. M.; Conservation Tillage: The Role of Operator Characteristics and the Perception of Soil Erosion; *Land Economics*; 65:167–182; 1989.

Gujarati, D.; *Basic Econometrics, 2^{nd} ed.*; McGraw- Hill Inc., New York; 1988.

Hurni, H.; Degradation and Conservation of Resources in the Ethiopian Highlands; *Mountain Research and Development*; 8(2/3):123–130; 1988.

ILCA; *Livestock Production System*; ILCA (International Livestock Center for Africa), Addis Ababa, Ethiopia; 1992.

Lapar, M. A. and Pandey, S.; Adoption of Soil Conservation: The Case of the Philippine Uplands; *Agricultural Economics*; 21:241–256; 1999.

Maddala, G. S.; *Limited Dependent and Qualitative Variables in Econometrics*; Cambridge University Press, Cambridge, MA; 1983.

Mbaga-Semgalawe, Z. and Folmer, H.; Household Adoption Behavior of Improved Soil Conservation: The Case of North Pare and West Usambara Mountains of Tanzania; *Land Use Policy*; 17:321–336; 2000.

Mulugeta, E., Belay, K. and Legesse, D.; Determinants of Adoption of Physical Soil Conservation Measures in Central Highlands of Ethiopia: The Case of Three

Districts of North Shewa Zone; *Agrekon*; 40(3):313–335; 2001.

Norris, P. E. and Batie, S.; Virginia Farmers' Soil Conservation Decisions: An Application of Tobit Analysis; *Southern Journal of Agricultural Economics*; 19(1):79–90; 1987.

Pattanayak, S. and Mercer, D. E.; Valuing Soil Conservation Benefits of Agroforestry: Contour Hedgerows in the Eastern Visayas, Philippines Uplands; *Agricultural Economics*; 18:31–46; 1998.

Pender, J. and Kerr, J.; Determinants of Farmers' Indigenous Soil and Water Conservation Investments in India's Semi-arid Tropics; EPTD Discussion Paper No. 7. International Food Policy Research Institute, Washington DC; 1996.

SCRP; Database of Gununo Research Project; SCRP (Soil Conservation Research Project), Addis Ababa, Ethiopia; 1988.

Shiferaw, B. and Holden, S. T.; Resource Degradation and Adoption of Land Conservation Technologies by Smallholders in the Ethiopian Highlands: A case Study; *Agricultural Economics*; 18:233–247; 1998.

Sureshwaran, S., Londhe, S. R. and Frazier, P.; A logit Model for Evaluating Farmer Participation in Soil Conservation programs: Slopping Agricultural Land Technology on Upland Farms in the Philippines; *Journal of Sustainable Agriculture*; 7(4):57–69; 1996.

World Bank; World Development Report 2003; Oxford University Press, New York; 2003.

Yohannes, G. M.; The effects of Conservation on Production in the Andit-Tid Area, Ethiopia; in: *Soil Conservation for Survival*, edited by Kebede, T. and Hurni, H.; Iowa State University Press; 1992.

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Effect of Neem Kernel Cake Powder (NKCP) on *Fusarium* Wilt of Tomato when Used as Soil Amendment

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Abstract

A study was conducted to investigate effect of Neem Kernel Cake Powder (NKCP) at 1.75, 3.5 and 7g rates on development of tomato *Fusarium* wilt in 1997 at the National Horticultural Research Center, Thika, Kenya. Inoculum density of *Fusarium oxysporum f.sp. lycopersici* (Sacc.) was two 14mm - diameter disks per planting hole taken from 10 day old cultures growing on PDA. Plant performance was based on shoot height and weight; stem diameter; number and weight of tomato fruits. Disease assessment was based on wilt index of shoots and length of discolouration of vascular tissues. Performance of plants grown in NKCP amended and non-amended soils was significantly (p=0.05) different (33.3 - 93.3%). Disease severity based on the wilt index (0.53-2.87) and length of discoloured vascular tissues (7.4cm - 25.62cm) differed significantly (p=0.05) among treatments.

Keywords: Neem kernel cake powder, *Fusarium oxysporum f. sp lycopersici*, tomato, wilt, soil amendment, plant performance, disease severity

1 Introduction

Tomato (*Lycopersicon esculentum* Mill) is an important source of vitamin C, calories, phosphorus and calcium (Davis and Hobson, 1981; Hobson and Kilby, 1985; Langer and Hill, 1991).

In 1990, the estimated area under tomato cultivation in Kenya was about 19,000 hectares with total annual production of 494,000 tons (Kibata, 1980). By 1995 the production had declined from the 494,000 tons to 225,310 (HCDA, 1995) due to constraints caused by environmental stress, diseases and poor agronomic practices.

Important tomato diseases include blights and wilts (Dixon, 1985; Alabouvette *et al.*, 1993; Kedera, 1996; Goth and Keane, 1997; Larkin and Fravel, 1998; AVRDC, 2001). Annual losses of up to 30,000 tons of canning tomatoes or 10-15% of the crop damage in the USA are associated with *Fusarium* tomato wilt (Westcott, 1971; Benhamou *et al.*, 1989). In Kenya, *Fusarium* wilt is known to cause significant tomato losses, (RRC-Kisii, 1994; Onyango and Makworo, 1997). In spite of the high tomato losses associated with *Fusarium* wilt its control is limited to use of fungicides which are unaffordable by the many poor resource Kenyan farmers. There is, therefore,

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need to seek alternative control measures that can be attractive to a poor resource farmer.

This study was undertaken to evaluate the effect of NKCP against *Fusarium* wilt when used as a soil amendment in the green house as a possible available alternative in the management of the *Fusarium* wilt disease in both poor and rich resource agricultural systems.

2 Materials and Methods

2.1 Isolation of *Fusarium oxysporum f.sp. lycopersici*

Fusarium oxysporum f.sp. lycopersici (Fol) was isolated from infested tomato plants collected from a farm at Kigumo, Kiambu District, Kenya in September 1996. Roots were thoroughly washed in tap water, rinsed with sterile distilled water and then aseptically cut into 1- cm-long pieces/segments. The root pieces were surface sterilized in 0.5% sodium hypochlorite solution for 30 seconds. The sterilized root segments were placed on Potato Dextrose Agar (PDA), five segments per petri dish (Waudo *et al.*, 1995) and incubated at 23°C for 10 days. Fol was identified using morphological characteristics (Nelson *et al.*, 1983). A pathogenity test was done to validate the identification. Pure cultures of Fol were maintained on PDA at 4°C.

2.2 Soil infestation

Soil infestation involved aseptically transferring of a 14mm - diameter disc of PDA taken from 10-day old cultures of Fol using a cork-borer into sterile soil, two disks per planting hole. The infested soil was then thoroughly mixed.

2.3 Greenhouse test

A test was conducted in a greenhouse at the National Horticultural Research Centre, Thika, Kenya to assess the effects of Neem Kernel Cake Powder (NKCP) on the development of *Fusarium* wilt of tomato, in soil amended with NKCP at the rate of 1.75, 3.5 and 7g. Inoculum density per planting hole was two PDA disks of culture transferred to sterile soil contained in 18cm- diameter pots as descried previously. Pots without NKCP served as controls.

Tomato seeds were germinated in sterilized sand contained in a $15 \times 20 \times 10$cm wooden box. Twenty-eight day old tomato seedlings were transplanted (one plant per pot) and treated with Di-amminium phosphate (DAP) fertilizer at the rate of 2g per pot. A completely radomized block design (CBD) with six replicates was used. Plants were watered appropriately and staked four weeks after transplanting.

Plant performance based on shoot height and weight, stem diameter, and number and weight of fruits was carried out. Shoot length was taken from the first basal node to the tip of the youngest apical bud. Stem diameter was taken just below the first basal node. Tomato shoots were cut at the first node and dried at 80°C for 72 hours before weighing. Shoot length and stem diameters were measured after every two weeks for eight weeks. Shoot weight, number and fruit weight were obtained at harvesting time.

Similarly, disease assessment based on length of discoloured vascular tissue and wilt index was done on harvesting day.

3 Results

Tomato plants grown in soil amended with different rates of NKCP differed (p=0.01) significantly in their performance. Tomato plants grown in soil amended with 7g of NKCP had the highest mean shoot height and stem diameter 42, 56, and 98 days after transplanting (Table 1). Mean shoot heights and stem diameter of the plants were lowest and highest in soils amended with 1.75 and 7.0g of NKCP. Plant performance decreased with reduction in the rate of NKCP 98 days after NKCP and Fol application (Table 1 and 2).

Table 1: Mean shoot height (SH) in cm and stem diameter (SD) in cm of tomato cv money maker after NKCP and Fol application.

Treatment * *(NKCP in g)*	*Days after NKCP application and Fol inoculation* †								
	14	*28*		*42*		*56*		*98*	
	SH	*SH*	*SD*	*SH*	*SD*	*SH*	*SD*	*SH*	*SD*
7	10.9 ^{b}	17.5 ^{ab}	0.67 ^{a}	38.3 ^{a}	0.86 ^{a}	51.4 ^{a}	1.06 ^{a}	80.8 ^{a}	1.14 ^{a}
3.5	13.2 ^{a}	19.3 ^{a}	0.72 ^{a}	35.5 ^{a}	0.90 ^{a}	50.7 ^{a}	0.99 ^{a}	76.0 ^{a}	1.03 ^{a}
1.75	9.75 ^{c}	16.4 ^{b}	0.53 ^{b}	27.9 ^{b}	0.81 ^{b}	36.4 ^{b}	0.81 ^{b}	55.7 ^{b}	0.82 ^{b}
Non-amended	9.58 ^{c}	13.9 ^{c}	0.32 ^{c}	21.3 ^{c}	0.54 ^{c}	25.9 ^{c}	0.54 ^{c}	41.8 ^{c}	0.59 ^{c}

* Each treatment was replicated 6 times

† Figures followed by the same letter within a column do not differ significantly (p=0.01) according to Duncan's Multiple Range Test (DMRT).

Tomato plants grown in soil amended with different rates of NKCP differed (p=0.01) significantly in their dry shoot weight (Table 3). Tomato plants grown in soil amended with 7g of NKCP had the highest dry shoot weight while those grown in non-amended soil had the lowest shoot weight 98 days after NKCP and Fol application (Table 3). Tomato plants grown in soil amended with 3.5g of NKCP had the second highest mean dry shoot weight while those grown in soil amended with 1.75g of NKCP had the second lowest mean dry shoot weight 98 days after NKCP and Fol application (Table 3). Similar trend was observed for tomato fruit weight (Table 3).

Tomato plants grown in soil, amended with different rates of NKCP differed (p=0.01) significantly in the number of mature red fruits 98 days after NKCP and Fol application (Table 3). However tomato plants grown in soil amended with 7g and 3.5g of NKCP did not differ significantly in the number of fruits they produced 98 days after NKCP and Fol application (Table 3). Tomato plants grown in soil amended with 1.75g of NKCP did not also differ significantly from those grown in non-amended (control) in the number

Table 2: Percentage (%) change in mean shoot height (SH) and stem diameter (SD) of tomato cv money maker 98 days after NKCP and Fol application.

Treatment * *(NKCP in g)*	*SH (cm)*	*% change*	*SD (cm)*	*% change*
7	80.8	93.3	1.14	93.2
3.5	76.0	81.8	1.03	74.6
1.75	55.7	33.3	0.82	39.0
Non-amended (control)	41.8	0	0.59	0

* Each treatment was replicated 6 times.

of mature red fruits 98 days after NKCP and Fol application (Table 3). Tomato plants grown in soil amended with 3.5g of NKCP had the highest mean fruit number while those grown in non-amended soil had the lowest mean fruit number (Table 3). Tomato plants grown in soil amended with 7g and 1.75g of NKCP had the second highest and second lowest mean fruit number, respectively (Table 3).

Table 3: Mean dry shoot weight (DSW) in grams, fruit weight (FW) in grams and fruit number (FN) of tomato cv moneymaker 98 days after NKCP application and Fol inoculation.

Treatment * *(NKCP in g)*	*Plant growth parameters*		
	DSW	*FW*	*FN*
7	38.59 ^{a} †	50.77 ^{a}	16 ^{a}
3.5	29.48 ^{b}	36.27 ^{b}	19 ^{a}
1.75	25.38 ^{c}	26.95 ^{c}	11 ^{b}
0 (Control)	17.8 ^{d}	11.93 ^{d}	8 ^{b}

* Each treatment was replicated 6 times.

† Figures followed by the same letter within a column do not differ significantly (p=0.01) according to DMRT.

Tomato plants grown in soil amended with different rates of NKCP differed (p=0.01) significantly in disease severity based on length of discoloured vascular tissue (LDV) and wilt index (WI), Table 4. Tomato plants from non-amended soil had the highest mean LDV and WI while those from soil amended with 7g of NKCP had the lowest LDV and WI means (Table 4). Tomato plants grown in soil amended with 3.5g and 1.75g of

Table 4: Mean length (cm) of discoloured vascular tissue (LDV) and wilt index (WI) of tomato cv money maker 98 days after NKCP application and Fol inoculation.

Treatment * *(NKCP in g)*	*Disease Parameters*	
	LDV	*WI*
7	7.42 ^{d}	0.53 ^{d}
3.5	13.97 ^{c}	0.95 ^{c}
1.75	22.77 ^{b}	2.53 ^{b}
0 (Control)	25.62 ^{a}	2.87 ^{a}

* Each treatment was replicated 6 times.

† Figures followed by the same letter within a column do not differ significantly (p=0.01) according to DMRT.

NKCP had the second lowest and second highest mean LDV and WI respectively 98 days after NKCP and Fol application (Table 4).

Disease severity (based on LDV and WI) on tomato plants decreased with increase in NKCP rates used as soil amendment (Table 4).

4 Discussion

The significantly (p=0.01) higher performance for tomato plants grown in soil amended with NKCP compared to those grown in non-amended soil (control) indicate that NKCP suppressed pathogenic effects of Fol (Table 1, 2, 3). The suppressive effect might have been due to production of fungistatic substances such as azadirachtin and improved host resistance perhaps as a result of improved host nutritional status (Schafer, 1971; Khan *et al.*, 1973; Maukau, 1980; Agrios, 1988). These possibilities, however, need to be investigated. Neem seed cake contains higher levels of nitrogen, phosphorus, potassium, calcium and magnesium than those in farmyard manure or sewage sludge (Radwanski and Wickens, 1981).

The significantly (p=0.01) short discoloured vascular tissues of plants grown in soil amended with 7g of NKCP (Table 4) indicates that high amount of NKCP suppressed the pathogenic effect of Fol. The poor disease development could be associated with enhanced performance of the tomato plants due to the high nitrogen nutrition from the neem seed cake (Huber and Watson, 1974; Tisdale *et al.*, 1985; Pacumbaba *et al.*, 1997).

References

Agrios, G. N.; *Plant Pathology, 3rd edition*; Academic Press Inc., New York; 1988.

Alabouvette, C., Lemanceau, P. and Steinberg, C.; Recent advances in the biological control of *Fusarium* wilts; *Pesticide Science*; 37:365–373; 1993.

AVRDC; Asian Vegetable Research and Development Center Report for 2000; Shanshua Taiwan, pp. 11 - 12; 2001.

Benhamou, N., Charest, P. M. and Jarvis, W. R.; Biology and host parasite relationships of *Fusarium oxysporum*; in: *Vascular Wilt Disease of Plants. Basic Studies and Control*, edited by Tjamos, E. C. and Beckmann, C. H.; NATO ASI H28; Springer Verlag; 1989.

Davis, K. M. and Hobson, G. E.; The constituents of tomato fruit - the influence of environment, nutrition and genotype; *Critical Reviews of Food Science and Nutrition*; 15:205–280; 1981.

Dixon, G. R.; *Vegetable Crop diseases*; pages 337–377; MacMillan; 1985.

Goth, R. W. and Keane, J.; A detached - leaf method to evaluate late blight resistance in potato and tomato; *American Potato Journal*; 74:347 – 352; 1997.

HCDA; The horticultural news HCDA magazine of the horticultural industry; Horticultural Crops Development Authority, Kenya; 1995.

Hobson, G. E. and Kilby, P.; Methods for tomato fruit analysis and indicators of consumer acceptability; Annual Report of the Glasshouse Crops Research Institute for 1984, pp. 129-136; 1985.

Huber, D. W. and Watson, R. D.; Nitrogen form and plant disease; *Ann. Rev. Phytopathol.*; 12:139–164; 1974.

Kedera, J.; *Plant Diseases*; vol. 30 of *Review of Kenyan Agricultural Research*; pages 28 –30; KARI/Bangor; 1996.

Khan, M. W., Khan, A. M. and Saxena, S. K.; Influence of oil - cake amendment on nematodes and fungi in tomato field; *Acta Bot. indica*; 1:49–54; 1973.

Kibata, G. N.; I.P.M. studies in Kenya; Special Report of the National Agri. Res. Inst., 41 pp.; 1980.

Langer, R. H. M. and Hill, G. D.; *Agricultural plants. Second Edition*; Cambridge University Press; 1991; 387 pp.

Larkin, R. P. and Fravel, D. R.; Efficacy of various fungal and bacterial biocontrol organisms for control of *Fusarium* wilt of tomato; *Plant Disease*; 82:1022–1029; 1998.

Maukau, R.; Biological control of nematode pests by natural enemies; *Ann. Rev. Phytopathol*; 18:415–440; 1980.

Nelson, P. E., Toussoun, T. A. and Marasas, W. F. O.; *Fusarium species; An illustrated manual for identification*; University Park, USA: Penasylvania State University Press; 1983.

Onyango, M. and Makworo, S.; Fruit and vegetable production practices and constraints in South West Kenya as a Basis for selecting Research Priorities; in: *A Review of Agriculture Practices and constraints in South West Kenya*; pages 47 – 61; KARI/DFID; 1997.

Pacumbaba, R. P., Brown, G. F. and Pacumbaba, R. O. Jr.; Effect of fertilizer and rates of application on incidence of soybean disease in northern Alabama; *Plant Dis.*; 81:1459–1460; 1997.

Radwanski, S. A. and Wickens, S.; Vegetative value and potential value of Neem tree in tropics; *Econ. Bot*; 35:398–414; 1981.

RRC-Kisii; KARI Regional Research Center Annual report for 1994; Kisii; 1994.

Schafer, J. F.; Tolerance to plant diseases; *Ann. Rev. Phytopathol.*; 9:235–252; 1971.

Tisdale, S. L., Nelson, W. L. and Beaton, J. D.; *Soil fertility and fertilizers*; Macmillan publishing company, New York; 1985.

Waudo, S. W., Owino, P. O. and Kuria, M.; Control of *Fusarium* wilt of tomatoes using soil amendments; *E. Afric Agri. For J*; 60(4):207–217; 1995.

Westcott, C.; *Westcott's Plant disease Handbook, 3 rd edn.*; Van Nostrand Reinhold Co., New York, London; 1971.

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Productivity and Breeding Strategies of Sheep in Indonesia: A Review

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Abstract

There are two distinct types of sheep in Indonesia: thin-tailed and fat-tailed, with some strain differentiation within each. The most important sheep breeds of Indonesia are the Javanese Thin Tail (JTT) and Javanese Fat Tail (JFT) sheep of West and East Java, respectively. Included are strains of thin tailed sheep Sumatra Thin Tailed (STT), Semarang, Garut and the Priangan sheep. The government also introduced some temperate sheep breeds (such as: Merino, Suffolk, Dorset, Suffas, Dormer, St.Croix and Barbados Blackbelly sheep).

The purposes of this paper are to review the potential of productivity for local sheep and their crosses with some imported sheep breeds. The concepts of breeding strategies for sheep in Indonesia are also discussed in three parts: (1) evaluation and improvement of local breeds (2) nucleus structure, and (3) gene migration (crossbreeding).

Keywords: sheep, breeds, breeding, Indonesia

1 Origin and Development of Indonesian Sheep

The breeds of sheep are classified according to fleece and tail type and roughly described in term of colour, horn, ears and product (Masson, 1991; Gatenby, 1995). There are 4 basic tail types in domestic sheep (Devendra and McLeroy, 1982): long-tailed, short-tailed, fat-tailed, and fat-rumped. Gatenby *et al.* (1994) reported that there are three general types of the sheep native to Southeast Asia: Small coarse-wooled sheep, fat-tail sheep of Eastern Indonesia, and long-tail wooled sheep of Thailand. In Indonesia, there are two distinct types: thin-tailed and fat-tailed, with some strain differentiation within each, particularly the thin-tailed group (Edey, 1983; Iniguez *et al.*, 1993; Bradford and Inounu, 1996). In the past some temperate sheep breeds such as Merino, Suffolk, Suffas, Dorset and, more recently, the Barbados Blackbelly, St.Croix-Virgin Island white hair sheep were introduced to Indonesia (RIAP and SRCRSP, 1990; Utoyo, 1995).

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1.1 Thin-tailed Types

The most numerous group in this class is the Javanese Thin-tail (JTT), the predominant type in West Java, which is the province with the largest sheep population (MERKENS and SOEMIRAT, 1979; RIAP and SRCRSP, 1990). The JTT sheep has some strains or local sub populations that are named after the local regions where they are prevalent, such as Garut and the Priangan sheep (INIGUEZ *et al.*, 1993). The Garut is popular as a fighting sheep and differs from the common thin-tailed sheep in its larger size and convex facial profile (EDEY, 1983).
Other strains of thin-tailed sheep in Indonesia include the Semarang, from Central Java and the Sumatra Thin-tail (STT) from the island of that name. The JTT sheep is a small animal, usually white but commonly has black patches around the eyes and nose and sometimes elsewhere (EDEY, 1983). The tail shows no sign of fat and does not reach the hocks. The ram has closely curled horns and the ewe is usually polled.

1.2 Fat-tailed Types

The Javanese Fat-tail (JFT) is a white, polled breed found predominantly in East Java (SUTAMA, 1990). Their tails range from rather modest-sized fat to extremely large tails. Among the fat-tailed populations the island of Madura has on average the most extreme fat tails (INIGUEZ *et al.*, 1993; EDEY, 1983).
The JFT sheep are the largest sheep breed of Indonesia. JFT are mostly white and relatively free of wool and some totally free. Both sexes are polled (INIGUEZ, 1990; INIGUEZ *et al.*, 1993). The typical fat-tailed sheep is completely white and is hornless in both sexes. Occasionally rams carry small horns. Fat-tailed sheep are larger than the thin-tailed (EDEY, 1983). MERKENS and SOEMIRAT (1979) noted a difference in disposition between JFT and JFT types with the JFT being much more docile.

2 Productivity of Sheep in Indonesia

There are many ways of changing the productivity of livestock (WIENER, 1994) and utilisation of genotypes based only on their performance within environments distinctly from those where they will be introduced can have devastating consequences (INIGUEZ *et al.*, 1993). The factors limiting the rearing of animals from temperate zones in the tropics are summarised by TAWFIK (2001): very little acclimatisation to adverse conditions, exposure to numerous diseases and the high demand of good feeding and rearing conditions.

As a result of a long process of adaptation, the action of natural and artificial selection and gene migration, Indonesia possesses three different indigenous sheep breeds that are distributed throughout its different tropical environments and are well suited for intensive and extensive exploitation (INIGUEZ *et al.*, 1993). Fewer animals have been selected for increased productivity in the humid tropics. In this part the production and reproduction performance of indigenous sheep and their crosses with imported breeds are presented.

INIGUEZ *et al.* (1991) have summarised the comparison for birth and weaning weights of Indonesian sheep (Table 1). Table 2 presents ewe weights at different parity. The STT ewe weight is considered to be the lightest and JFT sheep the heaviest. (SODIQ *et al.*, 1999) reported the weaning weights of JTT under the village management system which were improved by 7.03 ± 1.06 and 8.83 ± 0.58kg, respectively. INOUNU *et al.* (1993) showed that litter weaning weights were influenced significantly by prolificacy-year, parity and ewe weight gain. Lamb birth weight and weaning weight were heavier in male offspring and in small litters (INIGUEZ *et al.*, 1991).

Table 1: Birth and weaning weight of JTT, JFT and STT sheep.

Breed	*Birth weight (kg)*		*Weaning weight (kg)*	
	single	*multiple*	*single*	*multiple*
JTT	2.64	1.68	10.0	7.6
JFT	2.28	1.52	9.7	7.2
STT	2.13	1.50	10.8	7.0

Table 2: Ewe weight of JTT, JFT and STT sheep under different parities.

Breed	*Ewe weight (kg)*				
	Parity 1	*Parity 2*	*Parity 3*	*Parity 4*	*Parity 5*
JTT	22.8	25.0	26.9	28.6	29.9
JFT	22.9	25.8	27.1	27.1	26.9
STT	19.5	21.3	22.5	24.2	23.4

Performance of body weight of JFT and crosses with Dormer and Suffas at birth and weaning (SURYAPRATAMA, 1990) and at puberty (DARMOWIJONO, 1990) are presented in Table 3 and 4, respectively.

Table 3: Birth and weaning weight and daily gain in JFT, JFT×Dormer and JFT×Suffas

Breed	*Weight (kg)*		*Daily gain (g)*
	at birth	*at weaning*	
JFT	1.92 ± 0.13	6.92 ± 0.18	47.7 ± 6
JFT×Dormer	2.31 ± 0.28	9.94 ± 0.27	77.6 ± 9
JFT×Suffas	1.97 ± 0.20	8.85 ± 0.22	76.2 ± 8

Table 4: Weight at puberty of JFT, JFT×Dormer and JFT×Suffas

Breed	*Weight at puberty (kg)*			
	Males[1]	*Females*[1]	*Males*[2]	*Females*[2]
JFT	21.9	21.1	16.1	13.8
JFT×Dormer	24.9	21.9	-	-
JFT×Suffas	21.0	18.9	-	-

[1] Darmowijono (1990), [2] Sirait (1990),

Wijono (1990) studied the effect of crossbreeding on birth and weaning weight, weight at 7 months and at 10 months in JFT crossed with Dormas and Suffas sheep. In all cases crossbred animals were heavier than JFT (Table 5).

Table 5: Birth and weaning weight, weight at 7 and 10 months of JFT, JFT×Dormer and JFT×Suffas

Characteristics	*JFT*	*JFT x Dormas*	*JFT x Suffas*
Birth	2.40 ± 0.06	2.88 ± 0.01	2.79 ± 0.02
Weaning	7.21 ± 0.14	8.00 ± 0.14	8.24 ± 0.28
7 months	9.65 ± 0.17	11.73 ± 0.20	12.66 ± 0.31
10 months	12.7 ± 0.3	14.90 ± 0.41	16.50 ± 0.48

Santiarsa (1990) and Suryapratama (1990) reported birth and weaning weights and daily gains till weaning of an F_2 population. Their results are summarised in Table 6. The overall productivity of ewes per lambing (Table 7) were reported by Setiadi and Iniguez (1993). The JTT and JFT ewes weaned comparatively fewer kg lambs compared with the STT ewes which weaned up to 95 percent of lambs born.

The prolific Javanese ewes have been documented by some researchers (Inounu *et al.*, 1993; Roberts, 2000; Sumaryadi and Manalu, 1999). Subandriyo *et al.* (1996) and Gatenby *et al.* (1997) reported the productivity of Sumatra sheep and crosses with imported breeds St.Croix, Barbados Blackbelly (Table 8).

The carcass yield of JFT was lower than that of crossbreeds and comparable to the yield of the JTT (Komarudin, 1990). Table 9 presents carcass average for JFT and JFT (Herman, 1993). The data confirm a higher total fat content in carcasses of JFT than JTT. Carcass percentage of JTT ranged between 44 - 56 percent (Sodiq *et al.*, 1998a,b) and depend on the body weight at slaughter (Sodiq *et al.*, 1999).

Table 6: Average of birth and weaning weight and average daily gain from birth to weaning in F_1 and F_2 crossbreds.

Traits and breeds	F_1	F_2
Birth weight (kg)		
JFT	1.92 ± 0.13	2.15 ± 0.12
JFT×Dormer	2.31 ± 0.28	2.26 ± 0.16
JFT×Suffas	1.97 ± 0.24	1.66 ± 0.27
Weaning weight (kg)		
JFT	6.92 ± 0.18	9.34 ± 0.53
JFT×Dormer	9.94 ± 0.27	8.80 ± 0.96
JFT×Suffas	8.85 ± 0.68	6.98 ± 1.15
Daily gain (g)		
JFT	47.7 ± 6.00	67.90 ± 7.00
JFT×Dormer	77.60 ± 9.00	63.90 ± 9.00
JFT×Suffas	76.20 ± 8.00	50.30 ± 10.00

Table 7: Mean weight of lambs weaned per ewe per lambing from JTT, JFT and STT sheep

	Average (kg)	*% Ewe body weight*
JTT	9.29	35
JFT	9.04	35
STT	11.4	52

3 Breeding Strategies for Sheep in Indonesia

Research to generate new small ruminant technologies should cover various aspects including genetic improvement (SOEDJANA, 1993; SUBANDRIYO and DJAJANEGARA, 1995). A great number of studies have been dedicated to the possibilities of improving the efficiency of genetic programmes (FLAMANT, 1991). The general breeding strategy for any production environment is to match genetic potential to the feeding and management system (BRADFORD, 1993). In pursuing these goals, one needs to address questions such as: What are the ideal forages for those conditions; what are the most suitable animals breeds or crosses? (INIGUEZ *et al.*, 1993).

The genetic improvement should not be considered in isolation from the aspects of the environment (Wiener, 1994). Methods available for genetic improvement are: (a) selection between and within local available breeds, (b) development of improved

Table 8: Productivity of Sumatra sheep and crosses

Characteristic	*STT*	*STT* × *St.Croix*	*STT* × *Barbados Blackbelly*	*Composit* [1] *STT* × *St. Croix* × *Barbados Blackbelly*
Birth weight (kg)	1.88	2.23	2.15	2.45
Weaning weight (kg)	8.67	11.67	11.73	13.14
Litter size	1.5	1.49	1.67	1.46
Pre weaning growth (g/h)	81.50	97.4	108.2	101.5
Survival rate till weaning (%)	86.24	84.75	90.91	98.21
Productivity index (kg/ewe/y)	16.0	21.5	24.3	22.34

[1] 50% STT, 25% St. Croix and 25% Barbados Blackbelly

Table 9: Carcass characteristics of JTT and JFT

Characteristics	*JTT sheep*	*JFT sheep*
Slaughter weight (kg)	36.7	38.3
Carcass (kg)	20.2	21.4
Carcass (%) of slaughter weight	55.1	55.9
Muscle (%) of carcass	57.7	49.3
Fat (%) of carcass	26.8	36.2

type of animals by crossbreeding or gene migration (EDEY, 1983; INIGUEZ *et al.*, 1993; WIENER, 1994; SAKUL *et al.*, 1994). Breeding strategies for sheep production systems in the humid tropics such as Indonesia have been reported by some researchers: BRADFORD (1993), (INIGUEZ, 1990), (INIGUEZ *et al.*, 1993), SUBANDRIYO and DJAJANEGARA (1995), HARDJOSUBROTO (1995), ADJISOEDARMO (1997), ADJISOEDARMO *et al.* (1997). In general, their concept of breeding plan is summarised in three parts: (1) evaluation and improvement of local breeds, (2) nucleus structure, and (3) gene migration (crossbreeding).

3.1 Evaluation and Improvement of Local Breeds

Evaluation and improvement of local breeds is the first step to follow in a breeding program (INIGUEZ *et al.*, 1993; ADJISOEDARMO, 1997). Usually local breeds display considerable variation for most production traits so there is good potential for selection. The selection programs was been applied by ADJISOEDARMO *et al.* (1997) to create

genetically improved Javanese Thin Tailed sheep. NOOR *et al.* (2001) studied the selection to improve birth and weaning weight of Javanese Fat Tailed sheep.

The evaluation should then be made simultaneously with a selection program, for instance in a ram breeding nucleus plan. The flock should be established with a wide genetic base comprising a genetic pool of individuals from the local breeds. This sub population should represent a random sample of the whole population. However since the objective is also to raise production, screening of the local population for outstanding males and females could be useful and provide a one-step improvement of 10 to 15 percent in production (INIGUEZ *et al.*, 1993).

The screening should consider some traits: (a) selection of wool-free animals, (b) selection of twin-producing ewes if the environment allows for this level of prolificacy, for instance by selection of ewes that have produced at least five lambs in three lambings in two years, and (c) selection for desirable characteristics and against undesirable defects. The measurements should include: (a) lambing dates, (b) litter size, born and weaned, (c) ewe body weight at mating, lambing and weaning, (d) wool scores at birth and at adult age, (e) lamb birth and weaning weights, (f) lamb mortality, and (g) post weaning growth up to three months after weaning.

The adoption of the best mating system is mainly dictated by availability of labour and the need to group or synchronise lambings as well as other flock activities. The simplest system is continuous breeding which implies permanent presence of rams in the ewe flock except during late pregnancy and early lactation. Production under this system has proved to be effective for STT sheep. A non-continuous system could also be implemented. However, it increases lambing intervals. For instance, mating the ewes for a one month's period preceded and was followed by two months without exposure to rams, increased the lambing interval of STT from 201 to 232 days (INIGUEZ *et al.*, 1991).

3.2 Nucleus Structure

Fundamentally, a selection (evaluation) program involving direct participation of producers (end-users) would consist of: (a) A *central nucleus flock* to produce selected rams for breeding, preferably located at a research centre or government multiplication centre, and (b) *base flocks* where rams from the nucleus will be distributed. These would consist of smallholder flocks, commercial producers or government multiplication centres; with both types of flocks under performance monitoring.

The nucleus would require intensive recording of performance of the individual ewes as well as rams with identification of all animals. It should produce sufficient rams to be distributed among the base flocks for breeding purposes.

The number of animals in the nucleus will be defined on the basis of the number of participants, or, more properly, the number of animals in the total program. For instance, a nucleus flock of 400 STT ewes with an average litter size of 1.54 and with a capacity to lamb at a rate of three lambings in two years can produce at least 260 ram lambs per lambing (assuming 0.85 fertility). Of those there will be a reduction of 20 percent due

to pre weaning mortality and culling for defects, leaving about 210 rams to be tested for post weaning growth (until three to four months after weaning). Here a culling rate of 40 percent could be applied resulting in about 125 faster growing ram lambs. The top ten best ram lambs will be kept, while 60 to 80 could be distributed as ram lambs to be sold. If two rams are to be used on each farm comprising 20 to 30 breeding ewes, than 30 to 40 farmers could be part of the breeding program. The nucleus will produce its own breeding rams and replacement ewes.

The top 60 females will be kept as a replacement nucleus flock. However, outstanding females from the base flock could be introduced into the nucleus central flock during the program to minimise development of inbreeding in the flock. These ewes should be obtained throughout a fair agreement with participants. The nucleus females, by top rams produced at each lambing should be kept for breeds in the nucleus flock for no more than two years or three lambing seasons.

The participating (base) flocks would comprise performance-monitored farms, involving mainly groups of farmers such as those of the Outreach Research Project (ORP) of the Small Ruminants Collaborative Research Support Program (SR-CRSP) in North Sumatra. In this project, farmers participate in an on-farm research framework aimed at testing different technologies to improve sheep productivity. Initially, the farmers with four to six heads (flock) were preferable for the project. In the new breeding scheme for the Outreach Research Project (ORP) an increase of the flock size up to 20 to 30 ewes to be raised under a combination of cut and carry and grazing in the rubber plantations is being considered. A simple system of identification has been proven is to be implemented. Important (minimum) variables to record are: (1) Litter size, born and weaning, (2) lambing dates, (3) wool scores and (4) dam and lamb weaning weights (so that weight of lamb produced/ewe/year can be calculated).

3.3 Gene Migration (Crossbreeding)

Crossbreeding as a means of utilising differences between breeds has been widely used in sheep breeding in many countries (Rae, 1982). In order to avoid losses in adaptation present in the local breed, crossbreeding should be aimed at introducing desirable genes utilisation of local adaptability. The substitution of the local genes by upgrading to exotic breeds should only be practised where there is clear evidence that the resulting animals are more productive on a lifetime basis than the types they replace. Crossbreeding increases the heterozygote of a population, permitting the exploitation of heterosis. It may also be used for the formation of a new type of animal, a synthetic or new breed, which will combine desirable features of the parental breeds.

Some researchers apply the crossbreeding program for improvement of the Indonesian sheep. Merkel *et al.* (1999) concluded that the Sei Putih Hair sheep have relative growth potential and can contribute to increased sheep production in Indonesia. Gatenby *et al.* (1997) showed that the hair sheep crossbreds were more productive. Crossing the native Sumatra sheep with the two Caribbean breeds resulted in a increase in mature size and growth rate (Doloksaribu *et al.*, 2000).

The collaborative program between SR-CRSP has recently established a crossbreeding evaluation program involving the Saint Croix hair sheep from the Virgin Islands and STT sheep. The objectives are to assess the suitability of hair sheep for improvement of STT in the production systems such as those integrating sheep and under rubber plantations.

Concerning the optimum versus maximum genetic performance and tools for genetic improvement, there are several points to be noted (SUBANDRIYO and KEVIN, 1996) in the breeding strategies of sheep production:

(a) Breeds introduction or evaluation (selected breeds developed in a similar environment and look at full cycle)

(b) Records to keep (lambing dates, percentage and weaning weight)

(c) Selection criteria (post weaning growth of ram lambs and weight of lamb weaned per ewe)

(d) Role of government (professionally staffed breeding farm, selected for appropriate traits, selected breeding stock, provide information and service).

4 Zusammenfassung

Der Schafbestand in Indonesien besteht aus zwei Haupttypen: das Dünnschwanz- und das Fettschwanzschaf. Innerhalb der Schaftypen sind mehrere Schläge vorhanden.
Die wichtigsten Schafrassen in Indonesien sind das „Javanese Thin Tail (JTT)"- in Westjava und das „Javanese Fat Tail (JFT)" - Schaf in Ostjava. Weitere Dünnschwanzschafrassen sind „Sumatra Thin Tailed (STT)", „Semarang", „Garut" und „Priangan". Die Regierung in Indonesien importierte einige Schafrassen aus dem gemäßigten Klimabereich, wie Merino, Suffolk, Dorset, Suffas, Dormer, St. Croix und Barbados Blackbelly.

Das Ziel der vorliegenden Arbeit ist eine Zusammenstellung des Produktionspotentials der Lokalrassen und ihrer Kreuzungen mit den importierten Schafrassen in Indonesien. Das Zuchtkonzept beim Schaf wird in drei Abschnitten erläutert: Entwicklung und Verbesserung der Lokalrassen, Struktur der Zuchtherde und Kreuzungsprogramme.

References

ADJISOEDARMO, S.; Sistem perbibitan ternak Nasional ruang lingkup ternak ruminansia kecil ditinjau dari aspek mutu genetis, budidaya, standar dan pengawasan mutu [National breeding program for small ruminant, View on aspects: genetic, keeping, quality standard and evaluation]; Univ. of Jenderal Soedirman, Purwokerto, 31pp.; 1997; [Indonesian].

ADJISOEDARMO, S., PURNOMO, B., SUDEWO, A. T. A., MARMONO, E. and SANTOSA, S. A.; Santosa Mrnciptakan bibit unggul domba lokal menggunakan seleksi [Creating genetically improved local sheep by selection]; Research Report, Univ. of Jenderal Soedirman, Purwokerto, 31pp.; 1997; [Indonesian].

BRADFORD, G. E.; Small Ruminants Breeding Strategies for Indonesia; Proceedings of a Workshop held at the Research Institute for Animal Production, August 3-4; pp. 83-94; 1993.

Bradford, G. E. and Inounu, I.; Prolific breeds of Indonesia; in: *Prolific Sheep*, edited by Fahmy, M. H.; pages 137–145; CAB International, Wallingford, U.K.; 1996.

Darmowijono, S. A.; Pertumbuhan bobot badan DEG dan persilangnnya dengan Dormer dan Suffas [Growth of Fat Tailed sheep and crosses with Dormer and Suffas]; in: *Research on Javanese Fat tail Sheep at Gadjah Mada University*, edited by Astuti, M.; 1990; [Indonesian].

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

Doloksaribu, M., Gatenby, R. M., Subandriyo and Bradford, G. E.; Comparison of Sumatra sheep and hair sheep crossbreds. III. Reproductive performance of F_2 ewes and weight of lambs; *Small Ruminant Research*; 38(2):115–121; 2000.

Edey, T. N.; The genetic pool of sheep and goats; in: *Tropical Sheep and Goat Production*; pages 3–5; Australian Universities' International Development Program (AUIDP), Canberra; 1983.

Flamant, J. C.; Considering the Social Aspects of Sheep Breeding Programmes; in: *Genetic Resources of Pig, Sheep and Goat*, edited by Maijala, K.; World Animal Science Series; pages 379–390; Elsevier Science Publishers; 1991.

Gatenby, R. M.; *Sheep*; The Tropical Agriculturalist Series; CTA, Macmillan Education Ltd., London; 1995; 153pp.

Gatenby, R. M., Doloksaribu, M., Bradford, G. E. and Romjali, E.; The potential of hair sheep for the humid tropics of Southeast Asia; in: Proceedings of a Symposium on Strategic Development for Small Ruminant Production in Asia and the Pacific; Bali, July 11-16, pages 25-36; 1994.

Gatenby, R. M., Doloksaribu, M., Bradford, G. E., Romjali, E., Batubara, A. and Mirza, I.; Comparison of hairsheep and their crossbreeds II. Reproductive performance of F_1 ewes; *Small Ruminants Research*; 25(2):161–167; 1997.

Hardjosubroto, W.; Pola pemuliabiakan untuk peningkatan productivitas ternak lokal di Indonesia [Breeding strategy for livestock improvement in Indonesia]; Proceedings of the National Seminar of the Livestock and Veterinary, Nop 7-8, pages 51-59, Bogor; 1995; [Indonesian].

Herman, R.; Pertumbuhan dan komposisi tubuh dan karkas komparasi antara domba Priangan dan Domba Jawa Ekor Gemuk [Growth, body composition and carcass comparison between Priangan and Javanese Fat-tail sheep]; Dissertation, Institute of Agriculture, Bogor; 1993; [Indonesian].

Iniguez, L.; Towards the conservation and improvement of the Javanese Fat Tail sheep; in: Proceedings of a workshop on Production Aspects of Javanese fat tail sheep in Indonesia, Surabaya, August 10-11, pages 79-83; 1990.

Iniguez, L., Pattie, W. A. and Gunawan, B.; *Aspek-aspek pemuliabiakan domba pada lingkungan tropis basah [Aspects of sheep breeding with particular emphasis on humid tropical environments]*; pages 80–141; Sebelas Maret University Press; 1993; [Indonesian].

Iniguez, L., Sanchez, M. and Ginting, S. P.; Productivity of Sumatran sheep in a system integrated with rubber plantation; *Small Ruminant Research*; 5(4):303–317; 1991.

Inounu, I., Iniguez, L., Bradford, G. E., Subandriyo and Tiesnamurti, B.; Production performance of prolific Javanese ewes; *Small Ruminant Research*; 12(3):243–257; 1993.

Komarudin; Hubungan antara persentase karkas dengan bagian-bagian karkas domba lokal [Relation between the percentage of carcass and the carcass cut in local sheep]; Research Report. Gadjah Mada University; 1990; [Indonesian].

Masson, I. L.; Classification and Distribution of Sheep Breeds; in: *Genetic Resources of Pig, Sheep and Goat*, edited by Maijala, K.; World Animal Science Series; pages 179–193; Elsevier Science Publishers B.V.; 1991.

Merkel, R. C., Simanihuruk, K., Ginting, S. P., Sianipar, J., Batubara, L. P. and Pond, K. R.; Growth potential of five sheep genotypes in Indonesia; *Small Ruminant Research*; 34(1):11–14; 1999.

Merkens, J. and Soemirat, R.; Sumbangan pengetahuan tentang pemulianbiakan domba di Indonesia [Contribution to the knowledge of sheep breeding in Dutch East Indies]; Translation by LIPI, Bogor, pages 7-24; 1979; [Indonesian].

Noor, R. R., Djajanegara, A. and Schuler, L.; Selection to improve birth and weaning weight of Javanese Fat Tailed; *Archiv für Tierzucht - Archives of Animal Breeding*; 44(6):649–659; 2001.

Rae, A.; Breeding; in: *Sheep and Goat Production*, edited by Coop, I. E.; World Animal Science Series C1; pages 15–55; Elsevier Science Publishers; 1982.

RIAP and SRCRSP; Research Institute for Animal Production (RIAP) and Small Ruminant Collaborative Research Support Program (SRCRSP); Indonesian Small Ruminants Directory, ISRN, Bogor, 52pp.; 1990.

Roberts, J. A.; Frequency of the prolificacy gene in flocks of Indonesian Thin Tail sheep: A Review; *Small Ruminant Research*; 36(3):215–226; 2000.

Sakul, H., Bradford, G. E. and Subandriyo; Prospects for genetic improvement of small ruminants in Asia; in: Proceedings of a symposium on Strategic Development for Small Ruminant Production in Asia and the Pacific, July 11-16, pages 3-14, Bali; 1994.

Santiarsa, I. G.; Pertumbuhan cempe F_2 persilangan DEG dengan Domer dan Suffas [Growth rate till weaning of F_2 lambs crossing Fat Tailed sheep with Dormer and Suffas sheep]; in: *Research on Javanese Fat Tail Sheep at Gadjah Mada University*, edited by Astuti, M.; 1990; [Indonesian].

Setiadi, B. and Iniguez, L.; Reproduction performance of small ruminants in an on-farm research program with village farms in West Java; *Small Ruminant Research*; 12(1); 1993.

Sirait, M.; Rata-rata pertambahan bobot badan Domba Ekor Gemuk sejak disapih sampai pubertas [Averages body weight of Fat Tailed sheep from weaning till puberty]; in: *Research on Javanese Fat Tail Sheep at Gadjah Mada University*, edited by Astuti, M.; 1990; [Indonesian].

Sodiq, A., Priyono, A., Sugiyatno, Soedjadi and Marmono, E. A.; Produktivitas domba pada sistem pedesaan dan ditingkatkan [Ewe reproduction index under village and improved management systems]; Research Report, Univ. of Jenderal Soedirman, 66pp.; 1999; [Indonesian].

Sodiq, A., Setyaningrum, A. and Haryoko, I.; Study 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; 1998a; [Indonesian].

Sodiq, A., Soedjadi and Priyono, A.; Karakteristik karkas Domba Ekor Tipis di Banyumas [Carcass characteristics from Thin Tail Sheep in Banyumas]; Research Report; Univ. of Jenderal Soedirman, 42pp.; 1998b; [Indonesian].

Soedjana, T. J.; Direction of Future Small Ruminants Research and Development in Indonesia; in: Proceedings of a Workshop Held at the Research Institute for Animal Production, August 3-4, pages 3-64, Bogor; 1993.

Subandriyo and Djajanegara, A.; Potensi produktivitas ternak domba di Indonesia [The potential of productivity for sheep in Indonesia]; Proceedings of a National Veterinary Seminar, Nov. 7-8, Bogor; 1995; [Indonesian].

Subandriyo and Kevin, R. P.; Small Ruminants Production: Recommendations for Southeast Asia; *Indonesian Small Ruminant Network Newsletter*; 6(2):17–19; 1996.

Subandriyo, Setyadi, B., Rangkuti, M., Dwiyanto, K. and Batubara, L. P.; Pemuliaa Bangsa Domba Sintetis Hasil Persilangan Domba Lokal Sumatra dengan Domba Bulu [Breeding Synthetic Sheep Crossing between Local Sumatra Sheep and Hair Sheep]; Centre of Research and Development of Livestock, Bogor; 1996; [Indonesian].

Sumaryadi, Y. M. and Manalu, W.; Prediction of litter size based on hormones and blood metabolites concentrations during pregnancy in Javanese Thin Tail ewes; *Asian Australian Journal of Animal Sciences*; 12(5):682–688; 1999.

Suryapratama, W.; Perbandingan pertumbuhan cempe DEG dengan persilangan DEG dengan Domer dan Suffas [Comparison of growth rate till weaning between Fat Tailed sheep and crossing with Dormer and Suffas sheep]; in: *Research on Javanese Fat Tail Sheep at Gadjah Mada University*, edited by Astuti, M.; 1990; [Indonesian].

Sutama, K.; Production and reproductive performance of Javanese Fat Tail sheep; in: Proceedings of a workshop on Production Aspects of Javanese Fat Tail Sheep in Indonesia, Surabaya, August 10-11, pages 69-77; 1990.

Tawfik, E. T.; Basic Concept of Animal Breeding; Paper presented at a General Lecture in Jenderal Soedirman University, Purwokerto, Indonesia, September 29; 2001.

Utoyo, D. P.; Animal Genetic Resources in Indonesia; in: Proceedings of the First National Co-ordinators Meeting, FAO, Bangkok, January, pages 86-107; 1995.

Wiener, G.; *Animal Breeding*; Macmillan Education Ltd., London; 1994; 208pp.

Wijono, D. B.; Parameter fenotipik pertumbuhan DEG dan silangan Dormas dan Suffas [Phenotypic parameters of growth in Fat Tailed Sheep and Crosses with Dormer and Suffas sheep]; Thesis, Gadjah Mada University; 1990; [Indonesian].

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ДЕНДРОЛОГИЧЕСКИЙ АНАЛИЗ ПАРКОВ г. ДУШАНБЕ

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Dendrological analysis of the parks of Dushanbe

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Abstract
An analysis of tree varieties growing in the parks of Dushanbe (Tajikistan) is represented in this publication. The plants being found in the territories investigated are listed. Recommendations are given to improve the parks of the town.

Keywords: Dushanbe, Tajikistan, trees, varieties, park

Современной проблемой является сохранение окружающей среды и создание благоприятных и здоровых условий для жизни человека. В решении этой задачи ведущая роль отводится зеленым насаждениям произрастающим в условиях городской среды.

Любой город или поселок подразделяется на следующие зоны: промышленную, жилую, коммунально-складскую, внешнего транспорта и пригородную. Более подробно необходимо рассмотреть жилую зону, так как она предназначена для размещения жилых районов, общественных центров (административных, научных, учебных, медицинских, спортивных и др.) и непосредственно зеленых насаждений общего пользования.

К насаждениям общего пользования относятся городские парки и скверы, которые являются не только элементами архитектурных композиций и благоустройства, но и основным фактором определяющим санитарно-гигиенические и микроклиматические условия города. Иными словами природными фильтрами оптимизирующие окружающую среду.

Рассматриваемый район, т.е. город Душанбе расположен на высоте 800 м над уровнем моря, при этом климат здесь резко континентальный и среднегодовая темпера-

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тура воздуха составляет 14 °С, средний и абсолютный минимум самого холодного месяца (февраль) составляет -10 °С, средний и абсолютных годовых минимумов температуры - 17 °С. Самая высокая температура в июле равняется 45-48 °С. Зима очень мягкая, малоснежная, дождливая. Осадки в виде снега выпадают ежегодно, но снежный покров не устойчивый. Абсолютный минимум (- 29 °С) бывает раз в 35-40 лет. Лето жаркое, сухое. Среднегодовое количество осадков 500-610 (700) мм. Основная масса их выпадает в зимне-весенний период (В.Н. Владимирова, 1982).

В связи с такими погодными условиями оптимизация окружающей среды имеет особое значение для города Душанбе, по следующим причинам:

- неудачное месторасположение города как крупного промышленного центра,
- наличие естественного источника загрязнения (сероводород, мгла-афганец),
- расположение промышленных предприятий в селитебной зоне города и отсутствие в них санитарно-защитных зон,
- аэропорт, расположенный в черте города, который является тоже источником загрязнения,
- дефицит зеленых насаждений на душу городского населения (фактически 6 кв.м, при норме выше 28 кв.м).

Наиболее подробно необходимо остановиться на последнем моменте. Во многом данный фактор связан с бедным видовым составом, правильным подбором и размещением древесных пород в условиях города (Д.П. Никитин, Ю.В. Новиков, 1986).

Целью нашей работы является изучение видового состава и общего состояния древесных насаждений парков. Анализ дендрофлоры проводился с 2000 г. по 2003 г. В план входило изучение дендрофлоры пяти парков города: С.Айни, Центральный парк культуры и отдыха (ЦПКиО), Победы железнодорожный и Дружбы народов.

Проведенные исследования показали, что общее количество видов по всем паркам составило 78, все эти видов относятся к 27 семействам и 49 родам (табл.1). Распределение видов по паркам представлено следующим образом: С.Айни - 44, ЦПКиО - 40, Победы - 20, Железнодорожный - 16 и Дружбы народов - 26.

Таблица 1: Распределение растений по объектам г.Душанбе и их обилие

Название Растений	*По объектам*					*Обилие*		
	Парк С.Айни	*ЦПКиО ЦПКиО*	*Парк Победы*	*Ж/д парк*	*Дружбы народов*	*много много*	*мало мало*	*среднее среднее*
1. Ailanthus altissima (Miller) Swingle		+		+		+		
2. Albizia julibrissin Durazz.		+						+
3. Acer negundo L.	+	+		+	+	+		
4. Acer tataricum L.	+							+
5. Acer velutinum Boiss	+	+			+	+		

6. Aesculus hippocastanum L.	+	+		+		+	+	
7. Amygdalus bucharica Karsh.		+						
8. Berberis vulgaris L.	+							+
9. Betula ulmifolia Siebold et Zucc.	+	+					+	
10. Broussonetia papyrifera (L.) Vent.	+	+						+
11. Campsis radicans (L.)Seem.		+						+
12. Catalpa speciosa (Warder ex Engelm) Warder	+	+	+					+
13. Cedrus deadara (D.Don) G.Don.f.		+						+
14. Chamaecyparis lawsoniana Parl.	+		+					+
15. Crataegus hissarica Pojark.			+				+	
16. Crataegus pontica C.Koch.			+				+	
17. Cotinus coggygria Scop.			+				+	
18. Cupressus arizonica E.Greene			+		+		+	
19. Cupressus sempervirens L.	+	+			+	+		
20. Deutzia amurensis (Regel) Airy-Shaw	+							+
21. Elaeagnus orientalis L.	+							+
22. Euonymus japonica Thunb.	+	+		+			+	
23. Fraxinus excelsior L.	+	+		+		+		
24. Fraxinus lanceolata Borkh.				+		+		
25. Fraxinus sogdiana Bunge	+			+			+	
26. Fraxinus syriaca Boiss	+	+			+	+		
27. Gleditsia triacanthos L.					+		+	
28. Gymnocladus dioicus (L.) C.Koch.	+							+
29. Hibiscus siriacus L.	+	+		+	+	+		
30. Juglans regia L.	+	+		+	+		+	
31. Juniperus virginiana L.	+	+	+		+		+	
32. Juniperus communis L.	+	+	+		+		+	
33. Koelreuteria paniculata Laxm.		+		+		+		
34. Lagerstroemia indica L.		+			+		+	
35. Lauro-Cerasus officinalis Duh.	+	+				+		
36. Ligustrum lucidum Aitonf.	+							+
37. Ligustrum vulgare L.	+			+				+
38. Lonicera nummulariifolia Jaub.et Spach.	+							+
39. Lonicera tatarica L.	+							+
40. Maclura aurantiaca Nutt.					+			+
41. Morus alba L.	+	+		+	+	+		
42. Padus racemosa (Lam.) Gilib.		+						+
43. Philadelphus coronarius L.	+							+
44. Picea abies (L.) Karsten		+						+

45. Picea pungens Engelm.		+						+
46. Pinus brutia Ten	+	+	+			+		
47. Pinus pallasiana D.Don		+	+				+	
48. Pistacia vera L.			+	+	+	+		
49. Platanus orientalis L.	+	+	+	+	+	+		
50. Populus alba L.	+	+		+	+		+	
51. Pyracantha crenutata M. Roem	+							+
52. Quercus iberica Steven.	+	+			+		+	
53. Quercus ilex L.		+						+
54. Quercus macranthera Fischer. G. A. Meyer	+				+		+	
55. Quercus robur L.	+	+		+	+			
56. Quercus castaneifolia C. A. Meyer		+		+	+			
57. Robinia pseudacacia L.	+	+	+	+	+	+		
58. Salix exselsa S.G.Gmelin	+				+		+	
59. Salix babylonica L.		+			+		+	
60. Salix matrsudana Keidz.					+			+
61. Sequoiadendron giganteum (Lindley) Buchholz		+						+
62. Sophora japonica L.	+	+					+	
63. Spartium junceum L.	+		+		+		+	
64. Spiraea japonica L.f.	+							+
65. Spiraea thunbergii Siebold	+							+
66. Swida darvasica (Pojark.) Sojak	+						+	
67. Syringa vulgaris L.	+							+
68. Thuja occidentalis L.	+	+			+		+	
69. Thuja orientali L.	+	+	+		+	+		
70. Tilia caucasica Rupr.		+						+
71. Vitex agnus-castum L.					+			+
72. Viburnum tinus L.		+						+
73. Wistaria sinensis (Sims.) Sweet.	+							+
74. Ulmus adrosowii Litv.		+						+
75. Ulmus americana L.	+	+	+	+	+	+		
76. Ulmus pinato-ramosa Dieck.	+	+	+	+	+	+		
77. Ulmus scabra Mill.			+				+	
78. Ulmus pumila l.	+	+	+	+	+	+		

При рассмотрении ассортимента парка С.Айни ведущими породами являются *Quercus* и *Fraxinus*. Они представлены в насаждениях, как в чистом виде, так и в смешанных посадках. Большой интерес вызывают отдельные экземпляры дуба, которые достигают высоты 30 метров, а диаметр ствола составляет 60-65 см с раскидистой кроной до 17-20 м. Единичными экземплярами представлены очень экзотические виды бундук (*Gymnocladus dioicus*), кипарисовник (*Chamaecyparis lawsoniana*),

а из кустарников дейция (*Deutzia amunensis*), жимолость (*Lonicera numilarifolia*) и другие.

Рассматривая видовой состав древесной растительности ЦПКиО можно отметить, что ведущей породой является чинар (*Platanus orientalis*) высаженный в рядовых насаждениях вдоль аллей. Эти посадки были первыми озеленительными посадками города (за исключением очень старых экземпляров, которым в дальнейшем можно дать статус "Памятники природы"), в них позже был позаимствован шаг посадки (расстояние между деревьями в ряду) в насаждениях последних лет. Здесь можно встретить также одну из экзотических пород - мамонтово дерево (*Sequoiadendron giganteum*) высаженный в рядовых посадках с чинаром, имеющий оголенный ствол с небольшой кроной и достигающий высоты 25 м.

Насаждения парка Победы являлись в свое время лесными культурами Камчинского лесхоза и представляют собой своеобразный лесопарк. Доминирующей культурой здесь является фисташка настоящая (*Pistacia vera*) представленная в чистом виде. Эти насаждения являются первыми опытными посевами культуры фисташки в Таджикистане, осуществленные в конце 30-х годов. Посадки последующих лет связанные с организацией парка и расположены вокруг монумента и представлены, в основном, хвойными породами: можжевельник (*Juniperus*), кипарис (*Cupressus*), сосна (*Pinus*) и туи (*Thuja*). Особенно хотелось бы подчеркнуть присутствие в посадках, из числа хвойных, кедра гималайского (*Cedrus deodara*), который высажен в насыпном грунте на богаре. При этом все растения находятся в хорошем состоянии и имеют очень красивую декоративную крону.

Доминантными породами Железнодорожного парка являются клен американский (*Acer negundo*), акация белая (*Robinia pseudoacacia*), ясень зеленый (*Fraxinus lanceolata*) и кельритерия метельчатая (*Koelreuteria paniculata*). Все перечисленные виды были посажены до 40-х годов, за исключением кельритерии. Акация белая, клен американский и айлант высочайший местами полностью потеряли свою декоративность. Кроме этого, по парку можно наблюдать большое количество самосевных посадок и корневых отпрысков айланта и клена. Хотелось бы отметить, что в видовом составе парка почти полностью отсутствуют посадки кустарников, за исключением одного вида сирийской розы (*Hibiscus siriacus*).

Преобладающими породами парка Дружбы народа являются дуб и тополь (*Populus alba*). Все посадки относительно молодые и посажены редко. Очень много пустот, полян, редин и прогалин. В виде отдельных куртин отмечен тополь белый.

В таблице 2 приведено распределение исследованных видов по семействам. Анализируя полученные данные, можно отметить следующее, самим крупным семейством является *Leguminosae* представленное 8 родами, следом за ним следует семейства *Rosaceae* - 5 родов и *Cupressaceae* - 4 рода. Третья часть по убыванию представлена семействами насчитывающими по одному роду.

Хвойные породы представлены тремя семействами: *Cupressaceae*, *Pinaceae* и *Taxodiaceae*.

Таблица 2: Распределение видов по семействам

	Семейство	*Число родов*	*Число видов*	*В том числе:*				
				Парк им. С. Айни	*ЦПКиО*	*Парк Победы*	*Железнодор. парк*	*Дружбы народов*
1.	Aceraceae Juss.	1	3	3	2	-	1	2
2.	Anacardiaceae Lindley	1	1	-	-	1	-	-
3.	Berberidaceae Juss.	1	1	1	-	-	-	-
4.	Betulaceae S.F.Gray	1	1	1	1	-	-	-
5.	Bignoniaceae Juss.	1	1	1	1	-	-	-
6.	Caprifiliaceae Juss.	1	3	2	1	-	-	-
7.	Celastraceae R.Br.	1	1	1	1	-	-	-
8.	Cornaceae Dumort.	1	1	1	-	-	-	-
9.	Cupressaceae Bartl.	4	7	3	4	3	-	3
10.	Fagaceae Dumort.	1	5	4	3	-	1	5
11.	Hippocastanaceae DC	1	1	1	1	-	1	1
12.	Juglandaceae A. Richard ex Kunth.	1	1	1	1	-	1	-
13.	Leguminosae Juss.	8	8	4	4	1	2	1
14.	Malvaceae Juss.	1	1	1	1	-	1	1
15.	Moraceae Link.	3	3	2	2	-	1	2
16.	Oleaceae Hoffmgg. et Linl.	3	7	4	4	-	2	3
17.	Philadelphaceae D. Don	2	2	2	-	-	-	-
18.	Pinaceae Lindley	2	4	1	3	2	-	1
19.	Pistaciaceae (Marchand) Caruel.	1	1	-	-	1	-	-
20.	Platanaceae Dumort.	1	1	1	1	1	1	1
21.	Rosaceae Juss.	5	7	3	-	2	-	-
22.	Salicaceae Mirbel.	2	4	2	2	1	2	4
23.	Sapindaceae Juss.	1	1	1	1	-	1	-
24.	Simaroubaceae DC.	1	1	-	1	1	1	1
25.	Taxodiaceae Warming	1	1	-	1	-	-	-
26.	Tiliaceae Juss.	1	5	3	4	4	1	2
27.	Ulmaceae Mirbel.	1	5	-	1	-	-	1
28.	Verbenaceae Jaume St.- Hil.	1	1	-	-	-	-	1
	И Т О Г О	49	78					

Наиболее широко, из листенных пород представлены роды *Quercus* - 5 видов, *Ulmus* - 5 видов и *Fraxinus* - 4 вида. Остальные роды содержат только по одному виду. Наиболее распространенными семействами в исследованных парках являются: Leguminosae, Platanaceae, Salicaceae и Ulmaceae. Представители этих семейств встречаются во всех парках города. Меньшее распространение получили представители семейств Aceraceae, Cupressaceae, Hippocastanaceae, Malvaceae, Moraceae, Pinaceae и Simaroubaceae. Меньше всех в посадках встречаются представители семейств Anacardiaceae, Berberidaceae, Cornaceae, Philadelphaceae, Pistaciaceae, Taxodiaceae и Vitaceae.

Кустарники представлены в основном тремя семействами Caprifoliaceae, Philadelphaceae и Rosaceae.

Нами также был проведен и географический анализ видового состава древесных растений обследованных парков г.Душанбе проведен по флористическим областям Земного шара, выделенным А.Л. Тахтаджаном (1978), представлен в таблице 3.

Таблица 3: Распределение древесных растений парков г. Душанбе в зависимости от географического происхождения

Флористические области	*Количество видов*		*В том числе по паркам*				
	всего	*%*	*Им.С. Айни*	*ЦПКиО*	*Победы*	*Железнодор.*	*Дружбы народов*
Циркумбореальная	11	14,3	8	5	1	3	2
Восточно-азиатская	17	22,1	12	9	4	4	5
Атлантико-североамериканская	14	18,2	4	10	3	4	6
Средиземноморская	22	27,2	12	13	4	2	9
Ирано-туранская	14	18,2	8	4	8	3	4
И Т О Г О:	78	100	44	40	20	16	26

Растения выходцы из Циркумбореальной области в насаждениях парков представлены бедным ассортиментом и составили 14 % (11 видов), в основном эти виды встречаются в посадках парка им С.Айни (8 видов), практически отсутствуют в насаждениях парка Победы (1 вид - вяз шершавый (*Ulmus scabra*) произрастающий на участке без орошения). Наиболее распространенными видами являются *Quercus robur* L. и *Fraxinus exselsior* L. встречающиеся повсюду, за исключением парка Победы.

Представители Восточно-азиатской флористической области по количеству занимают второе место, что составляет 22 % (17 видов) от общего числа. Из них представлены широко *Ailanthus altissima*, *Euonymus japonica*, *Koelreuteria paniculata*, *Lagerstroemia indica* и другие. Больше всех они представлены в насаждениях

парка им.С.Айни. Некоторые виды данной области являются пионерами озеленения: *Ailanthus altissima* и *Gleditsia triacanthos*.

Менее шестой части всех видов используемых в озеленении парков составляют представители Атлантико-североамериканской области. Среди них много экзотов, которые по разным причинам не получили распространение в насаждениях парков города: *Chamaecyparis lawsoniana*, *Gymnocladus dioicus*, *Picea pungens*, *Sequoiadendron giganteum* и другие. Имеются также виды широко распространенные в насаждениях это *Acer negundo*, *Cupressus arizonica*, *Robinia pseudoacacia* и *Fraxinus lanceolata*. Больше всего этих видов встречатся в ЦПКиО, а меньшее их количество в парке Победы.

Четвертая часть (21 вид) представлена древесными растениями Средиземноморской области, которые объединяют виды встречающиеся во флоре Кавказа: *Albizia julibrissin*, *Cotinus coggygria*, *Quercus iberica*, *Tilia caucasica* и другие. Наиболее распространенными видами здесь являются *Acer velutinum*, *Aesculus hippocastanum*, *Salix babylonica*, *Frauxinus syriaca*. Представители данной области являются доминирующими в насаждениях ЦПКиО. Меньше всего их встречается в Железнодорожном парке. А из общего числа видов парка Дружбы народов эти виды занимают чуть меньше половины.

Ирано-Туранская группа растений представляет пятую часть от общего числа (14 видов). Представители этой группы являются преобладающими в двух парках им.С.Айни и Победы, где они являются доминантами. Наиболее распространенными видами аборигенной флоры являются Platanus orientales, Juglans regia, Populus alba.

По жизненным формам древесные растения исследованных парков г.Душанбе распространяются по системе И.Г. Серебрякова (1964) следующим образом (табл.4):

- вечнозеленые хвойные - 13 видов (16,9 %);
- одноствольные листопадные - 38 видов (49,3 %);
- кустовидные листопадные деревья - 7 видов (9,1 %);
- листопадные кустарники - 13 видов (16,3 %);
- листопадные лианы - 2 вида (*Campsis radicans*, *Wistaria sinensis*);
- одноствольные зимнезеленые деревья - 1 вид (*Quercus ilex*);
- кустовидные зимнезеленые деревья - 1 вид (*Lauro-Cerasus officinalis*);
- зимнезеленый кустарник - 1 вид (*Euonymus japonica*).

Анализируя жизненную форму видового состава парков можно сказать, что менее чем пятую часть составляют кустарники, которые в основном сконцентрированы в парке им.С.Айни. Хотя в естественной флоре данный биоморф в несколько раз превышает число деревьев. Это по нашему мнению вызвано следующим:

(1) В городских насаждениях используют больше число видов растений из таких районов как Средиземноморье, Восточная Азия, где в составе древесной

флоры соотношение видов приблизительно одинаково, а в некоторых районах деревья доминируют.

(2) Привлечены в первую очередь различные виды деревьев, как имеющие наибольшую хозяйственную и декоративную ценность (долголетие, оригинальность, разнообразие формы кроны и т.д.).

(3) В традиционных национальных садово-парковых насаждениях издавна было принято высаживать биоморфы деревья дающие хорошую тень. Результаты изучения динамики видового состава насаждений парков города Душанбе приводятся в диаграмме 1, где рассматривается видовой состав по периодам, когда в ассортименте появился вид.

Таблица 4: Распределение видов по жизненным формам

Таксоны	*Жизненные формы*	*Кол-во видов*	*Процент от общего числа*
Pinophyta	Вечнозеленые хвойные деревья	13	16,9
Magnoliophyta Magnoliopsida	Одноствольные листопадные деревья	38	49,3
	Кустовидные листопадные деревья	78	9,1
	Листопадные кустарники	14	16,9
	Листопадные лианы	2	2,6
	Одноствольное зимнезеленое дерево	1	1,3
	Кустовидные зимнезеленые деревья	2	2,6
	Зимнезеленые кустарники	1	1,3
	И Т О Г О:	78	100

Динамика видового состава охватывает четыре периода: первый приходится на сороковые годы, где в ассортименте встречаются пионеры озеленения, не только парков, но и города в целом. В основном насаждения данного периода встречаются в Железнодорожном парке (самый первый парк города) и насчитывает 9 % от общего числа. Сюда относятся *Ailanthus altissima*, *Acer negundo*, *Gleditsia triacanthos*, *Robinia pseudacacia*, *Fraxinus lanceolata*. А в насаждениях парка Победы встречаются *Amygdalus bucharica*, *Pistacia vera*. Отдельные экземпляры этого периода можно наблюдать и на территории ЦПКиО. Все виды на период обследования потеряли декоративные качества за исключением *Pistacia vera*. Некоторые из них дают самосевы засоряя чистые посадки (*Ailanthus altissima*, *Acer negundo*).

Наибольшее количество видов приходится на второй период и составляет 63,1 %, который относится к шестидесятым годам. Ассортимент представленный этим периодом в основном встречается в ЦПКиО и сохранился до настоящего времени. Наиболее распространенными видами являются *Aesculus hippocastanum*, *Juniperus virginiana*, *Koelreuteria paniculata*, *Pinus brutia*, *Platanus orientalis*, *Populus alba*, *Quer-*

cus robur, *Salix excelsa*, *Thuja orientalis*, *Ulmus pinato-ramosa*, *U. pumila*, *Fraxinus excelsior* и *F. syriaca*. Появление первых хвойных древесных пород в озеленительном ассортименте приходится также на данный период и они представлены следующими видами: *Cedrus deadara*, *Cupressus sempervirens*, *Juniperus vinginiana*, *J. communis*, *Pinus brutia*, *Thuja occidentalis* и *T. orientalis*.

Третий период относится к восьмидесятым годам и представлен небольшим ассортиментов видов, но более декоративных 27,9 % или 19 видов от общего числа. Особое место среди них занимают вечнозелено-лиственные породы: *Euonymus japonica*, *Lauro-Cerasus officinalis*, *Ligustrum lucidum* и *Quercus ilex*. Более 30 % от общего числа приходится на долю хвойных пород, представленные, в том числе и экзотами: *Chamaecyporis lawsoniana*, *Cupressus arizonica*, *Picea pungens* и *Sequoiadendron giganteum*. В ассортименте также встречается редкая для озеленения жизненная форма - лиана - *Wistaria sinensis* (парк им.С.Айни).

Четвертый период охватывает последнее десятилетие двадцатого века, в ассортименте фактически отсутствуют новые виды. Хотя в этот период можно отметить появление интересных видов деревьев и кустарников (*Magnolia grandiflora*, *M. liliflora*, *Abies pinsapo*, *Cedrus atlantica*, *Yucca filamentosa*, *Mahonia*, *Danae*, *Cuningamia*, *Buxsus* и другие), которые создают особый колорит парковой зоны придавая ей вид типичной субтропической растительности.

Таким образом, проведенный анализ современного состояния дендрофлоры города Душанбе позволяет сделать выводы о том, что все парки нуждаются в квалифицированном пересмотре ассортимента, реконструкции имеющихся посадок и введения новых наиболее перспективных и устойчивых к загрязнению городской среды видов деревьев (*Aesculus hippocastanum*, *Cedrus atlantica*, *Parrotia persica* и другое), кустарников (*Laqerstroemia indica*, *Viburnum orulus var.seterila* и другие) и лиан (*Parthenocissus quinquifolia*, *Wistaria sinensis*, *Jasminum officinale* и другие), которые прошли успешные испытания в условиях Центрального ботанического сада Академии наук Республики Таджикистан.

Резюме

В работе приводится краткий анализ дендрофлоры парков города Душанбе (Таджикистан). Приводится анотированный список растений произрастающих в исследуемой зоне. Даются предварительные рекомендации по улучшению ассортимента парковой зоны города.

Литература

Владимирова В.Н.; Характеристика основных элементов климата. - В кн.: Таджикистан (природа и природные ресурсы), Душанбе, Дониш, 1982. С. 152-199.

Никитин Д.П., Новиков Ю.В.; Окружающая среда и человек. М., Высшая школа, 1986, с. 101-121.

Растения для декоративного садоводства Таджикистана. М., Наука, 1986. 496 с.

Серебряков И.Г.; Жизненные формы растений и их изучение. - В кн.: Полевая геоботаника, т. III. М., Наука. 1964.

Тахтаджан А.Л.; Флористические области земли. Л., 1978.

Journal of Agriculture and Rural Development in the Tropics and Subtropics
Volume 105, No. 1, 2004, page 94

Announcement

Deutscher Tropentag 2004

Rural Poverty Reduction through Research for Development and Transformation

Humboldt-Universität zu Berlin, Agriculture and Horticulture Faculty

October 5-7, 2004

Further information under: http://www.tropentag.de/

From the Deutscher Tropentag 2003:

International Research on Food Security, Natural Resource Management and Rural Development
Technological and Institutional Innovations for Sustainable Rural Development

Georg-August-University Göttingen,, October 8 - 10, 2003

Finally available:

- Remarks on Tropentag 2003
- Presentations - Proceedings

Abstracts and full papers are fulltext searchable now under:
http://www.tropentag.de/2003/proceedings/

Journal of Agriculture and Rural Development in the Tropics and Subtropics
Volume 105, No. 1, 2004, pages 95–98

Announcement

1st Conference on Sheep, Goats and Desert Animals Production in Hot Climate

7-9 September, 2004

Organized by

The Egyptian Association of Sheep, Goats and Desert Animals Production

to be held at

International Centre for Agriculture, Dokki, Cairo Egypt

The Conference will be held under the Auspices of Professor Dr. Youssef Wally, Deputy Prime Minister and Minister of Agriculture and Land reclamation.

Scientists and all who are concerned with Sheep, Goats and Desert Animals Production, are invited.

Objectives of the Conference

- To exchange ideas and information on: Reservation of sheep, goats and desert animals in different environments.
- To discuss various means for increasing sheep, goats and desert animals for their specific production.
- To exchange ideas and information on advances being made in sheep, goats and desert animals.
- Evaluation of new developments in different production systems.

The main subjects are:

Breeding & Genetics; Nutrition; Physiology; Husbandry; Wool & Hair; Economic; Diseases; Others.

Conference language:

English

Registration Fees (Payable to Account No.17217, Cairo Bank, Dokki Branch, Geiza, Egypt):
Egyptians

Non-members of the Association:
– 300 L.E. before 1st May.
– 350 L.E. after 1st May.
Members of the Association:
– 280 L.E. before 1st May.
– 330 L.E. after 1st May.
Accompanying persons:
– 250 L.E. before1st May.
– 300 L.E. after 1st May.

Non-Egyptians

Participants:
– 250$ before 1st May.
– 300$ after 1st May.
Accompanying persons:
– 200$ before1st May.
– 250$ after1st May.

The registration fees will include:

Attendance, publications, Tea-Breaks and transporting during the conference days.

Accommodation:

Accommodation will be available at Cairo Hotels. Details of Booking will be sent later.

Paper Format

All papers accepted will be printed in a proceeding. All paper should be written according to the system of the Egyptian Journal of Sheep, Goats and Desert Animals as follows:

- Manuscripts of 3 copies on one column should be typed double-spaced on quarto size with a wide margin. The manuscript should not be longer than 10 pages of Din A4 paper, double space, including tables, figures and references.
- Following the title(s), author(s) name(s) (with initials preceding) and address(es), articles are often divided into the following sections: Summary (not more than 250 words), Introduction, Materials and Methods, Results and Discussion, Conclusions, Acknowledgment(s) and References.
- Photos should be high gloss-prints of good contrast. Tables, figures and photos should be located in the text and each is numbered consecutively.
- In the Text, References of one or two Authors should be by their Surnames and year. References of more than two names are shown as the Surname of the first Author and *et al.* In the List of References, References should have an alphabetical order giving: Surname(s) and abbreviated first name(s) of the Author(s), year, title of the paper, name of the Journal (i.e. place of publication) complete (not abbreviated), number of the volume (Bold), numbers of the first and last pages. For Books, title and place of publication should be mentioned.
- Latin names in the Text and titles of books and Journals in the List of References should be written in *Italics*.
- Weights and measures must be expressed in the metric system and temperatures in centigrade.
- All pages including those of tables and figures must be numbered.
- The definitive draft, typed and recorded on a diskette should be submitted in Word-star, Word-perfect or as an ASCII file. Author(s) will be charged 10 L.E. for each extra page. The text will be reproduced by Camera Ready System. Please make sure that the originals are of excellent quality print and written only on one side. Diskette 3.5" Win-Word 6 software and two copies of full article should be sent.
- Scientific manuscripts in Arabic language with ample summary may be accepted, with the same rules mentioned above.

Closing date:

Deadlines of submitting abstract is 1st May and full paper in 15th July, 2004.

Cancellation:

There will be no cancellations after 31st July, 2004.

Post-Conference Optional Tours:

After the end of the Conference, attractive tours for participants who are interested to visit historical and cultural sites in Egypt, will be available. Full details and timetable will be announced later.

Pre-registration form:

Surname/Family name:_____

First name:_____

Affiliated Institution or Company:_____

Mailing Address:_____

Street:_____

No.:_____

City:_____

Post code/Zip:_____

Country:_____

Fax:_____

E-mail:_____

Abstract title:_____

I intend to submit a presentation:

☐ Oral ☐ Poster ☐ No

Please return this form by mail, Fax or E-mail.

All Correspondence should be addressed to:

Prof. Dr. I. Fayez M. Marai
The Egyptian Association of Sheep, Goats and Desert Animals Production.
5 Nadi El-Saed Street, Dokki, Geiza, Egypt.
E-mail: eagela@hotmail.com

Journal of Agriculture and Rural Development in the Tropics and Subtropics
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Buchbesprechungen

Schleiff, Uwe; 2003

Handbook 'Salinity and Soil Fertility Kit'. A portable field lab for soil, water and plant analysis.

self-published; 168 p.; Price per copy: € 170.00 plus packing and postage.
http://salinity.schleiff.net
Orders by email: schleiff.uwe@t-online.de, or by fax: +49-5331-907 440

The handbook is the result of many years of field experience in the application of rapid chemical test-kits for testing important parameters on soil fertility (salinity, alkalinity, pH, nutrients, CEC, ESP Cl, $\mathrm{NO_3}$, gypsum, carbonate etc.), quality of irrigation-, ground- and drainage waters ($\mathrm{EC_{eff.}}$, SAR and $\mathrm{SAR_{Mg-adj.}}$ etc) and nutrient status of plants ($\mathrm{N, P, K}$). The presented methods are developed to serve as effective tools to identify, to manage and to monitor limiting factors for growth of plants (ranging from salt-sensitive plants to halophytes) and environment under saline conditions. More than 100 tables and figures are offered for data evaluation with respect to crop production and environment protection. Special attention is given to Mg-salinity with respect to soil physical effects. The urgent need for a separate evaluation of soil osmotic and soil matric water potentials on plant water supply and plant growth is postulated. In addition a general concept on the contribution of the rhizospheric soil for the salt tolerance of plants is presented (horizontal salt distribution around roots of different morphologies within irrigation cycles). The handbook addresses to agronomists, soil chemists, irrigation engineers and environmentalists involved in the preparation and implementation, monitoring and evaluation of irrigated areas opposed to salt-affected soils, saline waters and environments. For more information, please visit the homepage, which offers an expanded list of contents including tables and figures.

C. Richter, Witzenhausen

Pohlan, J.; 2002

México y la Cafeticultura Chiapaneca - Reflexiones y alternativas para los caficultores.

400 páginas, 68 ilustraciones y tabla de contenidos, en español, Shaker Verlag Aachen, ISBN 3-8322-0514-4. € 26.00

Bajo el Título: "México y la Cafeticultura Chiapaneca - Reflexiones y alternativas para los caficultores" se presenta el nuevo libro editado por el Dr. H. Alfred Jürgen Pohlan y publicado por la Editorial Shaker. El libro surge en momentos en que la cafeticultura

sufre su más grande crisis a nivel mundial, reflejada en los bajos precios del grano en el mecado internacional con graves consecuencias socioeconómicas en el seno de los paises productores, particularmente de América Latina. Paradójicamente, la crisis cafetalera representa para los productores una valiosa oportunidad para diversificar sus sistemas de producción, ya que los obliga a encontrar fuentes alternativas de ingreso, a reducir sus costos de producción y a producir de una manera más amigable al ambiente, haciendo amplio uso de los recursos naturales existentes en su entorno. En ese contexto, el rescate del conocimiento local es crucial para diseñar sistemas de producción estables, eficientes y duraderos. Precisamente es este punto donde radica la principal fortaleza del libro. El contenido de la obra se basa en las memorias del Curso de Diplomado Internacional que ofrece el Colegio de la Frontera Sur (ECOSUR) de Tapachula en Chiapas, México, y que está dirigido a un amplio sector de interesados, incluyendo productores, estudiantes y técnicos entre otros. El libro comprende siete capítulos (El café en México y en Chiapas; Los requerimientos edafo-climáticos y la biodiversidad; El sistema café; Transformación y diversificación de la producción cafetalera; Beneficiado de café, calidad y comercialización; Recursos humanos y aspectos sociales; y un capítulo sobre Las prácticas del Diplomado y sus anécdotas). Contiene en sus 400 páginas un total de 54 ilustraciones a color y numerosas tablas que sintetizan valiosa información de orientación práctica. El listado de autores está compuesto de cuarenta y cuatro personas, entre académicos de prestigiosas universidades de Centro América, México, Estados Unidos y Alemania, y productores agroecológicos y orgánicos de larga tradición cafetalera, lo que convierte a la obra no solo en una fuente vigorosa de conocimientos prácticos y resultados científicos, sino también en una base de información e ideas innovativas de gran utilidad para el diseño y manejo de sistemas sostenibles de producción cafetalera más allá de las fronteras del Estado Chiapaneco.

Victor Blandón Rivera, Witzenhausen

Journal of Agriculture and Rural Development in the Tropics and Subtropics
Volume 105, No. 1, 2004, pages 101–102

Kurznachrichten

Uni Kassel entwickelt Verfahren zur Analyse ökologischer und konventioneller Lebensmittel

Kassel/Witzenhausen. Neue wissenschaftliche Methoden können ökologische von konventionellen Lebensmitteln aus Anbauversuchen unterscheiden. Mit ihren Ergebnissen bot eine Gruppe von Forschern der Universität Kassel in Witzenhausen und von privaten Forschungseinrichtungen, der KWALIS Qualitätsforschung Fulda GmbH, Dipperz, und der EQC GmbH, Weidenbach, auf der europäischen Wissenschaftskonferenz „New Approaches in Food Quality Analysis“ Mitte November 2003 in Berlin reichlich Diskussionsstoff. Bislang konnte die Produktqualität von Lebensmitteln der beiden Produktionsverfahren analytisch nicht unterschieden werden. Die vorhandenen Methoden waren nicht geeignet, neue und komplementäre Methoden hingegen nicht ausreichend überprüft.
In dem vorgestellten Projekt validierten die Forscher die neuen bildschaffenden, spektralanalytischen und elektro-chemischen Methoden nach der Norm ISO 17025. Es gelang ihnen bei standardisierten ökologischen und konventionellen Weizen- sowie Möhrenproben aus Anbauversuchen des schweizerischen Forschungsinstituts für biologischen Landbau (FiBL) signifikante Unterschiede der Anbausysteme zu belegen. Zentrale Rolle spielt dabei die Methode der Kupferchlorid-Kristallisation: In ökologischen und konventionellen Produktproben entstehen bei der Analyse signifikant unterschiedliche Kristallmuster. Diese wurden mit einem Computerprogramm ausgewertet.

Unter Anwesenheit von Staatssekretär Alexander Müller vom Bundesministerium für Verbraucherschutz, Ernährung und Landwirtschaft (BMVEL) diskutierten rund 50 Wissenschaftlerinnen und Wissenschaftler aus der universitären, freien und der Ressortforschung acht europäischer Länder die Ergebnisse der neuen Methoden. Diese können durchaus als Meilenstein in der Qualitätsforschung bezeichnet werden, so Dr. Johannes Kahl, Mitarbeiter des in Witzenhausen ansässigen Fachgebiets Ökologische Lebensmittelqualität und Ernährungskultur der Universität Kassel. Ziel ist, künftig ökologische und konventionelle Lebensmittel am Produkt zu unterscheiden. Damit würde das gegenwärtige Kontrollverfahren zur Sicherstellung der Prozesse ergänzt und die Verbrauchersicherheit sowie das Vertrauen in die Produktherkunft gestärkt.
Allerdings müssen die neuen Methoden noch verfeinert und überprüft werden, bis es möglich sein wird, generell ökologische und konventionelle Produkte auf analytischem Wege zu unterscheiden. Hier kann die Variation der Produktproben aufgrund der unterschiedlichen Wachstums- und Standortbedingungen eine Rolle spielen, so Kahl. Dieser Aufgabe stellen sich die Forscher nun in Zusammenarbeit mit Bundesforschungseinrichtungen.

Die Versuche zu diesem Forschungsprojekt wurden im Jahr 2002 unter Koordination von Prof. Dr. Angelika Meier-Ploeger, Fachgebiet Ökologische Lebensmittelqualität und Ernährungskultur der Universität Kassel, mit Unterstützung des Instituts für ökologischen Landbau der FAL (OEL-FAL), Trenthorst, und dem Forschungsinstitut für biologischen Landbau (FiBL) in der Schweiz begonnen. Das Bundesprogramm Ökologischer Landbau hat diese Forschungen finanziell unterstützt.

Bewertung von Lebensmitteln verschiedener Produktionsverfahren - Statusbericht 2003 Tauscher, B., Brack, G., Flachowsky, G., Henning, M., Köpke, U., Meier-Ploeger, A., Münzing, K., Niggli, U., Pabst, K., Rahmann, G., Willhöft, C., Mayer-Miebach, E. (2003): www.bmvel-forschung.de, pp 161

Pressemitteilung 03/04 - 23. Januar 2004, Beate Deuker

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Notes to authors

The Journal of Agriculture in the Tropics and Subtropics publishes papers and short communications dealing with original research in the fields of rural economy and farm management, plant production, soil science, animal nutrition and animal husbandry, veterinary hygiene and protection against epidemics, forestry and forest economy.
The sole responsibility for the contents rests with the author. The papers must not have been submitted elsewhere for publication. If accepted, they may not be published elsewhere without the permission of the editors.
Manuscripts are accepted in German, English, French, and Spanish. Papers may not be published in the order of receipt, those that require minor amendments, only are likely to appear earlier. Authors are advised to retain one copy of the manuscript themselves as the editors cannot accept any responsibility for damage or loss of manuscripts.

1. *Contents of the manuscripts*

Findings should be presented as brief as possible. Publication of a paper in consecutive parts will be considered in exceptional cases.
The following set-up is recommended:
The introduction should be as brief as possible and should concentrate on the main topics of the paper. Reference should be made to recent and important literature on the subject, only.
Materials used and methods applied should be explained briefly. Well-known or established methods and procedures should not be described. New or important methods should be explained. With all its brevity, this part should enable the reader to assess the findings adequately.
Tables and Figures should be used to effectively present the results. Explanations and other remarks on the results can be included in the text.
Discussion of results should also refer to relevant literature on the topic and lead to clear conclusions. Recommendations with respect to further research needed on the respective subject will increase the value of the paper.
The summary should concentrate on the main results and conclusions to highlight the author's contribution. It should be suitable for information storage and retrieval.

2. *Form of the manuscripts*

Manuscripts should be typed double-spaced with a wide margin, preferable on disk.
The documents should be prepared with standard software (Microsoft Word, Word Perfect, LaTeX). Alternatively, the manuscript can be submitted as a simple text/rtf file together with a printed version of the original format.
Please do not use automated or manual hyphenation.
Title, headings and references (names of authors) should not be in capitals.

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

The manuscript should not be longer than 15 typed pages including tables, figures and references.
The title of the paper is followed by the name(s) and address(es) of the author(s).
The abstract should be followed by a list of keywords (up to eight).
For each paper, a summary must be submitted in the same language (not more than 20 lines) and in English, if the paper is written in an other language.

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

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

S.I. (System International) units have to be used throughout.
References in the text should be made by the name of the author and the year.
Each paper should have an alphabetical list of references giving name and abbreviated first name of the author(s), title of the paper, name of the journal, number of the volume, year, page numbers; for books: title, place of publication, and year.
On publication, each author will receive two copy of the Journal

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