Village stratification for policy analysis: multiple development domains in the Ethiopian Highlands

Kruseman, G., J.Pender, G.Tesfay and B.Gebremedhin

Working Paper 2002-01

Policies for Sustainable Land Management in the Ethiopian Highlands

IFPRI-WUR project *Policies for Sustainable Land management in the Ethiopian Highlands*

Land degradation problems--including soil nutrient depletion, soil erosion, deforestation and other concerns--are severe in the Ethiopian highlands. These problems are contributing to low and declining agricultural productivity, poverty and food insecurity. The proximate causes of these problems are relatively well known. Underlying these proximate causes are many more fundamental causes. These more fundamental causes are affected by many aspects of government policy. Assessing the impact of different causal factors and identifying effective policy strategies to improve land management is a critical research challenge that has not yet been solved. In part, this is due to the complexity of factors influencing the problem. "One-size-fits-all" policy or program approaches are unlikely to be broadly successful. There is thus a general need and desire for more effective targeting of policy strategies towards specific regions and groups, although this depends on improved information about the potential impacts of alternative strategies.

The long-term goal, immediate purpose and specific objectives of the project are as follows:

Long-Term Goal:
To contribute to improved land management in the Ethiopian highlands, in order to increase agricultural productivity, reduce poverty and ensure sustainable use of natural resources.

Immediate Purpose:
To help policy makers in Ethiopia identify and assess strategies, including technology development policies, to achieve that goal.

Specific Objectives:
- To identify the key factors influencing land management in the Ethiopian highlands and their implications for agricultural productivity, sustainability and poverty;
- To identify and assess policy, institutional and technological strategies to promote more productive, sustainable, and poverty reducing land management;
- To strengthen the capacity of collaborators in the Ethiopian highlands to develop and implement such strategies, based upon policy research; and
- To increase awareness of the underlying causes of land degradation problems in the Ethiopian highlands and promising strategies for solving the problems.

The research takes place in Tigray, Northern Ethiopia. The project started in January 2001 and will continue until December 2003.

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More information can be found at the project web site:
www.sls.wau.nl/oe/pimea

The Participants

The WUR component of the project is co-ordinated by the **Development Economics Group** of **Wageningen University**. Next to overall project management, the DEG is responsible for bio-economic modelling and backstopping of research activities.

For more information and ordering of working papers contact:
Dr. G. Kruseman
Tel : +31 (0) 317 484668
Fax: +31 (0) 317 484037
Gideon.Kruseman@wur.nl

WAGENINGEN UNIVERSITY
SOCIAL SCIENCES

The **Trade and Development Group** of the **Agricultural Economics Research Institute** (LEI) is responsible analysis of current and alternative agricultural activities, using the NUTMON methodology.

For more information:
G. Meijerink
Tel : +31 (0)70 3358243
Fax: +31 (0)70 3615624
G.M.Meijerink@wur.nl

LEI

Plant Research International (PRI) is responsible for analysis of potential activities, using TCGs, and the analysis of the dynamics of natural resources.

For more information:
Dr. H.Hengsdijk
Tel : +31 (0) 317 475913
Fax: +31 (0) 317 418094
h.hengsdijk@wur.nl

ALTERRA is responsible for the spatial aspects of sustainable land management and the scaling-up of biophysical processes, using the LISEM model.

For more information:
Dr. M.E. Mosugu
Tel : +31 (0)317 474648
Fax: +31 (0)317 419000
m.e.mosugu@wur.nl

In Ethiopia the local partner is **Mekelle University**. MU is responsible for facilitation of PhD and other research conducted within the framework of the project.

For more information:
Dereje Aberra
Derejeaa@yahoo.com

The other project partner is the **International Food Policy Research Institute**. IFPRI is primarily responsible for the marketing analysis.

For more information:
Dr. J.Pender
j.pender@CGIAR.ORG

IFPRI

G. Kruseman

Village stratification for policy analysis: multiple development domains in the Ethiopian Highlands / G.Kruseman, J.Pender, G.Tesfay and B.Gebremedhin
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List of *Policies for Sustainable Land Management in the Ethiopian Highlands* working papers:

2002-01	Kruseman, G., J.Pender, G.Tesfay and B.Gebremedhin *Village stratification for policy analysis: multiple development domains in the Ethiopian Highlands.*
2002-02	Kinfe Abraha Weldemichael *Public and private labour investments and institutions for soil and water conservation in Tigray, Northern Ethiopia.*
2002-03	Boetkees, S. *Rural credit and soil and water conservation: a case study in tigray, Northern Ethiopia.*
2002-04	Kruseman, G., R.Ruben, G. Tesfay *Diversity and Development Domains in the Ethiopian Highlands*

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Village stratification for policy analysis: multiple development domains in the Ethiopian Highlands

G.Kruseman, J.Pender, G.Tesfay and B.Gebremedhin

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1 Abstract

In this paper we use the notion of development domains to stratify villages in the Ethiopian highlands in order to distinguish different development opportunities for local communities. The stratification is based on quantitative analysis of village survey data.
Development domains are an important concept in policy debates on sustainable development. They offer scope for discussing targeted interventions. Development domains commonly defined by dimensions such as agricultural potential, market access and population density can be quantified using readily available data.
In this paper the concept of development domains is used to characterize villages in northern Ethiopia using information from a community level survey. The scores on different dimensions of the domains are used to explain differences in livelihood strategies in terms of crop and livestock enterprises, and use of institutions.

***Keywords**:* *Development pathways, livelihood strategies*

2 Introduction

Many countries in sub-Saharan Africa suffer for interlinked problems related to poverty and natural resource degradation. Ethiopia is no different, except that in many parts of the highlands these problems are amongst the severest found in the continent. The notion of development domains is commonly used to target development interactions. The dimensions of development domains usually encompass agricultural potential, market access and population density. These dimensions adequately distinguish between situations where Malthusian and Boserupian development takes place. Areas with high population density, low agricultural potential and low market access can be expected to follow a Malthusian development. In a Malthusian development scenario land resources are typically mined completely until it is no longer productive. Boserupian development occurs when there is sufficient market access so specialization occurs leading to a more efficient use of scarce resources. The idea of *more people less erosion* (Tiffen *et al,* 1994) hinges on this concept. The proximity of markets allows a development of more sustainable agricultural systems. In many parts of Africa, soils are so poor that maximum carrying capacity occurs at low population densities (Kruseman, 2000).

These issues are often addressed in an anecdotal fashion, where quantitative analysis is needed to identify the possibilities of targeted interventions. This implies quantifying those dimensions that are important in the debate on differential development strategies. These dimensions are exogenous to the households trying to cope in their biophysical and socio-economic environment. Household choice variables are the result of their livelihood strategies. The exogenous dimensions commonly used in distinguishing between development domains are agricultural potential (biophysical environment), population density and market access (socio-economic environment).

Quantification of development domains has practical use. It allows a framework for further analysis needed to design development interventions appropriate for the area to which it is targeted. Within this framework of analysis many different approaches might be considered, ranging from econometric analysis of survey data to bio-economic modeling. Especially for the latter approach a village stratification is important in order to construct the appropriate model with structural relationships reflecting the development domains.

Targeting of development interventions can be done in different ways. Principally it can be focussed on specific groups or on specific regions or on both. The notion of development pathways is used to distinguish help determine potential focus points of interventions.

In this paper we concentrate regions and not on individual households. The main objective is to determine whether there is scope of targeting on geographic basis.

In this paper a method is used for stratifying villages into development domains using multivariate analysis of a broad community based survey. We then determine the importance of these development domains for livelihood strategies. This indicates to what degree geographical targeting might be useful.

The output of the analysis is a stratification of households into development domains.

The paper is structured along the following lines. In the next section the notion of development domains is discussed within the context of the Ethiopian highlands. Then the methodology to derive the quantified development domain dimensions is presented. The next sections discuss the results. Finally we briefly discuss the implications of this analysis for targeting of development interventions.

3 Development domains in the context of the Ethiopian highlands

The need to adequately address the formidable problems facing northern Ethiopia with the modest means available implies that choices have to be made where to target specific

activities. Not all activities are suitable for each community and different communities are bound to benefit most from different policies. If we cannot expect a “one-size-fits-all” strategy, criteria must be used to differentiate between communities and the strategies best for them. To get a handle on the possible differences the notion of development domains is used (Pender *et al.,* 1998; Fitsum Hagos *et al.,* 1999). This concept hinges on the notion that it is possible to find common elements to any successful development strategy. By concentrating on the main elements that bind or segregate different situations a limited number of development strategies can be identified.
One of the main hypotheses of development domains concept is the existence of differences in comparative advantages of alternative livelihood strategies, leading to different development pathways. Differences in comparative advantage can be attributed to three main factors: agricultural potential, market access, and population pressure.

Agricultural potential is a term that reflects a number of different underlying factors, including rainfall, soil type and quality, altitude, slope, topography, presence of pests and diseases. These are (to a large extent) exogenous variables to the farm households but of overriding importance for the absolute comparative advantage of producing different kinds of agricultural commodities in a specific setting. This potential varies with the commodity under consideration and over time as a result of human-induced (e.g. soil degradation) and exogenous change (e.g. climate change). The multi-dimensional aspect of agricultural potential, especially the fact that it can change over time should be taken into account in developing medium and long-term strategies.

Market access is critical for determining the comparative advantage of a specific locality for producing a specific commodity. Market access is a multi-dimensional factor encompassing o.a. distance to roads, quality of roads, travel time, distance to markets and urban centers, degree of competition, information costs, transport opportunities. Although many factors play a role, travel time is a crucial one that is the result of some (distance, quality of roads and transport opportunities) and of influence on others (information costs). It is therefore possible to find a measurable proxy for this important factor. Market access is closely linked to the concept of transaction costs whereby the penalty related to lack of market access influences farm household decisions related to consumption and production (Goetz, 1992; Omamo, 1998)

Population pressure has long been acknowledged as being a major driving force with respect to the labor intensity of agriculture, creating a conducive environment for innovations in technology, institutions, markets and infrastructure (Boserup, 1965; Ruthenberg, 1980; Hayami and Ruttan, 1985; Biswanger and McIntire, 1987). Population pressure affects labor utilization decisions and hence agricultural management practices as well as the return to different types of investments.

These three main factors obviously interact with each other in complex ways. In general population pressure tends to be higher when there is greater agricultural potential, better market access or both, allowing the existing population to make a living while encouraging migration from less favored areas. On the other hand increased population pressure is considered a major contributing factor to the severe land degradation found in many parts of Africa, reducing the agricultural potential. Market access tends to be better in highly populated areas since the per capita costs of infrastructural investment is lower, while it tends to be better in high agricultural potential areas since the returns to investment are higher. In their seminal study of Machakos, Tiffen *et al.* (1994) made a case for increased population pressure leading to less soil degradation. In this specific case, good market access permitted the necessary investments to reverse the process of soil degradation and allowing alternative

employment outside agriculture taking pressure from the land. The lack of these market opportunities has led to accelerated degradation in Rwanda. In the case of low population density in a low agricultural potential zone with limited market access small changes in population dynamics can set off a chain of events leading to degradation beyond the point of no return, as in the case of the Mossi plateau in Burkina Faso.
In short, market access and population pressure is very often correlated in some way. Increases in population pressure may lead increased market access, while increased market access may cause immigration and hence increased population pressure. Similarly agricultural potential can have a similar relationship with population pressure.

With three criteria each with an arbitrary two levels to each dimension a total of eight different categories of situations can be identified in the case study area (Fitsum Hagos *et al.*, 1999). Fitsum Hagos *et al.* use, what they call, “an unavoidable element of arbitrariness” in defining the categories.

4 Methodology

To get a handle on the classification of situations in the highlands of Ethiopia a more statistically robust methodology is welcomed. Two questions are important here.

- The first question is whether we can quantify the dimensions of the development domains in such a way that it becomes manageable.
- The second question is whether or not the dimensions of development domains we identify are mutually independent. Understanding interrelationships between these dimensions is needed to adequately distinguish what kind of interventions might be useful.

The methodology proposed in this paper makes use of the availability of a village level survey of 100 households in the case study area. The goal of the exercise is to classify each village (kushet) into a three dimensional matrix of factors influencing development potential. At the same time an analysis of livelihood strategies derived from the same survey will give an indication of the development opportunities in each category.
The first main factor influencing development potential is agricultural potential. The main factors contributing to agricultural potential are rainfall, altitude, and initial soil quality. The community level survey provides data with respect to altitude, and qualitative measures of soil quality. Rainfall data from other sources was combined with the community survey.
The second factor is market access, measured in terms of distances and walking times to roads, transportation, markets, etc. This information is available from the survey.
The third factor is population density directly available in the survey data.

For each dimension there are usually a number of different variables available that are related to it. To choose a useful proxy variable is not always easy. Especially in the case of agricultural potential which in it self is a multi dimensional dimension we should guard against arbitrariness. By using factor analysis to reduce the data, single quantitative measures are derived for each main factor. This has the advantage of being to use all the variables in the data set that are relevant while preventing to a large extent the occurrence of dependency amongst the development domain dimensions.

Because we are not able to *a priori* determine if the development domain dimensions are completely independent, we test for this independence using two staged least squares and seemingly unrelated regression.

Once we have quantified the development dimensions we can do a rough analysis on the variables related to livelihood strategies and development opportunities within the community survey. This analysis consists of regressing the development domain dimensions on sets of those variables. Three sets are related to agricultural production: cropping systems, livestock activities, and technology choice. One set is related to credit use and one set is related to welfare indicators. If development domains are important in determining development pathways then these variables that are an outcome of the current development pathways of the communities in Tigray should depend to some degree on the development domain dimensions.

Once we have determined if the dimensions are important we can stratify the villages in the survey using these dimensions. Instead of using cluster analysis to fit households into quasi-arbitrary categories, we opt for a more structural approach to identify the extremes using the available dimensions. We do this by dividing the households into three groups for each dimension depending on whether they score high, low or intermediate on each dimension. We do this because development domain dimensions in general tend to present themselves on a sliding scale and not just as extremes. We do however know where we want to end up in the stratification so cluster analysis which does not take this type of information into account is less appropriate.

5 Results: defining development domain dimensions

This section presents the results from the analysis and compares these to the hypothetical development opportunities presented by Fitsum Hagos *et al* (1999). Population density is captured by the corresponding variable in the community survey and, therefore, no proxy is needed. We choose to include population density in the factor analysis in order to get a normalized value for this variable. With respect to agricultural potential there are a number of different dimensions. In order to get very clear variables we choose to combine a limited number of variables in a number of data reduction steps. Table 1 presents factor analysis results for defining agricultural potential related to soil quality. The variables include proportions of different quality classes of cultivated and grazing land.

Table 1 factor analysis results for soil quality in agricultural potential

	Level of degradation	Soil quality
proportion of severely eroded cultivated land	0.822	0.103
proportion of moderately eroded cultivated land	0.578	0.461
proportion of severely eroded grazing land	0.779	-0.03
proportion of moderately eroded grazing land	0.863	-0.07
proportion of good soil	-0.303	0.882
% of Variance loaded onto the factor (Extraction Sums of Squared Loadings)	49.04	20.14

Note: Extraction Method: Principal Component Analysis

The extracted factors were given names that capture the information from the data reduction. Other components of the agricultural potential dimension are elevation and precipitation. By combining these two factors in the factor analysis normalized values can be obtained. Note that data on elevation was obtained from two different sources

Table 2 factor analysis results for rainfall and altitude in agricultural potential

	elevation	Rainfall
expected annual precipitation	0.053	0.997
elevation	0.989	-0.010
lower bound on altitude	0.937	-0.115
upper bound on altitude	0.901	0.048
mean altitude	0.980	0.023
% of Variance loaded onto the factor (Extraction Sums of Squared Loadings)	72.65	20.21

Note: Extraction Method: Principal Component Analysis

Using population density figures from two sources the normalized values are obtained:

Table 3 factor analysis results for population density

	Population density
Population density 1	0.998
Population density 2	0.998
% of Variance loaded onto the factor (Extraction Sums of Squared Loadings)	99.51

Note: Extraction Method: Principal Component Analysis

Market access is split into two separate factors. The first factor relates to physical distance from markets and infrastructure (see Table 4), the second relates to the presence of external institutions that facilitate market access (see Table 5).

We have chosen not to use all the variables related to distance available in the community survey. A number of variables related to walking time and distance to local (grain mills) and social infrastructure (schools and medical services) are excluded from the analysis. They load onto a separate factor that is not expected to have a very important influence on development domains. Table 4 shows that a village being remote means being remote in all respects.

Table 4 factor analysis results for market access - distance

	Market access
walking time to market center	0.932
walking time to bus service	0.876
Walking time to all weather road	0.919
Distance to town	0.875
Distance to all weather road	0.881
% of Variance loaded on factors (Extraction Sums of Squared Loadings)	80.44

Note: Extraction Method: Principal Component Analysis

Table 5 shows the interrelationships of the presence of institutions. The first factor loads the presence of water associations and the promotion of irrigation. The second factor loads the presence of cooperatives and indicates that there is a negative correlation between the presence of cooperatives and the availability of credit by the Bureau of Agriculture. The third factor loads the availability of credit by the Bureau of Agriculture and the active promotion of improved livestock practices. The fourth factor loads the apparent filling in of the credit gap by commercial credit (traders and moneylenders) in those areas where REST does not have a strong presence. The interesting part in this analysis is that it is not clear *a priori* if these factors are endogenous or exogenous. It could be that institutional presence is a result of the other dimensions in development domains. We therefore need to test for independence specifically for these points.

Table 5 factor analysis results for market access - institutions

	irrigation institutions	Cooperatives	livestock promotion and Bur. of Agriculture.	REST versus commercial credit
market cooperative	0.37	0.65	0.21	0.00
consumer cooperative	0.37	0.77	-0.08	0.05
water association	-0.71	0.39	0.31	0.15
credit by REST	0.35	-0.03	-0.34	0.64
credit by Bureau of Agriculture	0.22	-0.47	0.70	0.06
irrigation promoted	-0.75	0.24	0.26	0.23
livestock improvement promoted	0.41	0.00	0.61	0.45
commercial credit	0.26	0.18	0.33	-0.61
% of Variance loaded on factors (Extraction Sums of Squared Loadings)	21.8	18.6	16.3	13.2

Note: Extraction Method: Principal Component Analysis

6 Results: independence of development domain dimensions

Summarizing the factors determining development domains we have for agricultural potential: precipitation (RF), two variables defining soil quality (one is soil quality (SQ), the other is degradation level (DL), and elevation (EL). Population density (PD) and market access (MK) are captured in single variables. As mentioned earlier, *a priori*, not all these factors can be considered independent. We therefore test for linkages between these factors.

$DL = f(SQ, RF, PD, MK)$

The inherent soil quality, rainfall, market access and population density may influence degradation level.

$PD = f(DL, SQ, RF, EL, MK)$

Population density may be caused by a variety of factors relating to all the other factors determining development domains.

$MK = f(SQ, RF, EL, PD)$

Market access may be related to market access and to geographic location.

For each of the institutional factors (IF_i) we test

$IF = f(SQ, DL, PD, MK, EL)$

In this system of equations the independent variables are not completely independent because they may be endogenously determined. Variables that are not endogenously determined are inherent soil quality, elevation, and rainfall. Degradation level is correlated with rainfall, population density with inherent soil quality, elevation and rainfall, market access is correlated with elevation. There is no problem here because there is no endogenous determination. In the case of institutional factors there is a problem with endogeneity since some of the factors depend on population density and market access besides being slightly correlated to exogenous factors. This implies that we need to use three staged least squares to determine which right hand side variables should be in the equations.

Table 6: Seemingly unrelated regression

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.014684	0.105404	0.139314	0.8893
C(3)	-0.180838	0.102093	-1.771318	0.0772
C(5)	-0.005327	0.101794	-0.052332	0.9583
C(6)	0.269610	0.098317	2.742260	0.0064
C(9)	-0.062211	0.094130	-0.660899	0.5090
C(10)	-0.175459	0.095058	-1.845812	0.0656
C(21)	0.024632	0.088957	0.276904	0.7820
C(23)	-0.356143	0.088511	-4.023723	0.0001
C(39)	0.046754	0.087677	0.533248	0.5941
C(40)	-0.375532	0.095723	-3.923100	0.0001
C(42)	-0.199350	0.084739	-2.352503	0.0191
C(43)	0.188829	0.088622	2.130709	0.0337
Determinant residual covariance			0.327875	

Equation: DL = C(1) + C(3)*RF
Observations: 91
Adjusted R-squared 0.005799

Equation: PD= C(5) + C(6)*SQ
Observations: 91

Adjusted R-squared 0.053624

Equation: MK = C(9) + C(10)*EL
Observations: 89
Adjusted R-squared 0.032988

Equation: IF1 = C(21) +C(23)*PD
Observations: 96
Adjusted R-squared 0.132453

Equation: IF4 = C(39) + C(40)*MK +C(42)*RF +C(43)*SQ
Observations: 84
Adjusted R-squared 0.210172

7 Results: livelihood strategies

We determine development domain dimensions for the explicit purpose of determining development domains and corresponding development pathways. Although this paper is not intended as an exploration of development options, it makes sense to check the influence of development domain dimensions on development strategies in the communities. To do so a number of indicators for these strategies in terms of the choice variables of farm households are examined. Choice variables are not independent so we first reduce the number of variables to a set of independent variables using factor analysis. We do this in four domains of household decision making. The first is crop choice, which is expected to depend very much on differences agricultural potential but also on market access and population density. Together they determine the comparative advantage for the production of certain crops over others. The second domain is livestock activities. These activities differ from crop choice in that they entail long-term investments in animal numbers. Again we expect development domains to be partly determinant. The third domain we explore is technology choice. More than the previous two domains, technology choice hinges on this concept of development domains and pathways. The fourth domain we explore looks at credit use, not so much the availability but the use itself which is endogenous decision of farm households. The fifth and last domain we explore are a number of development indicators.

The first domain is crop choice. The community survey data we use in this analysis are the proportions of each crop in the community agricultural system. We therefore do not look at individual choices but the aggregate outcome of individual choice at village level. In Table 7 this information is summarized.
From this data it becomes clear that barley and teff are the major crops in the region, followed at a distance by maize wheat, sorghum and finger millet.

Table 7 Proportions of different crops in the cropping systems

	Minimum	Maximum	Mean	Std. Deviation
Barley	0	0.80	0.217	0.203
Maize	0	0.60	0.128	0.138
Wheat	0	0.50	0.106	0.119
Sorghum	0	0.80	0.092	0.159
Finger millet	0	0.60	0.074	0.105
Teff	0	0.85	0.205	0.177
Millet	0	0.33	0.031	0.054
Chick peas	0	0.25	0.028	0.036
Faba beans	0	0.75	0.045	0.086
Lentil	0	0.25	0.017	0.032
Files pea	0	0.50	0.023	0.057
Vatch	0	0.13	0.012	0.026
Flax	0	0.13	0.023	0.024
Sunflower	0	0.05	0.001	0.006
Sesame	0	0.25	0.003	0.025
Haricot beans	0	0.20	0.009	0.031

The results from the factor analysis are highlighted in table 8. The factors extracted are given names that indicate what they stand for. The 16 crops in the cropping system can be summarized in 6 cropping systems axes. The first one juxtaposes the barley wheat pulses system of the higher altitudes to the lower altitude sorghum based system. When can therefore expect altitude dimension to play a role in explaining this factor. The second system juxtaposes a sorghum based system and a millet based system. Since both are lower altitude crops altitude should not play a role here. Probably rainfall plays a role, since millet is more drought resistant. The maize system requires higher rainfall. Some of the systems contain cash crops that require better market access (sesame, sunflower, possibly haricot beans), so there is ample scope for explaining these systems using development domain dimensions.

Table 8 Cropping systems

	barley wheat faba lentil pea system vs sorghum teff haricot	sorghum haricot system versus millet vatch	maize finger millet chick pea system	chick pea vatch	teff vatch sesame	millet flax versus sunflower
Barley	0.666	-0.253	-0.366	0.057	-0.269	-0.154
Maize	-0.295	0.374	0.617	0.090	-0.228	-0.203
Wheat	0.718	-0.175	-0.220	0.109	0.125	-0.197
Sorghum	-0.516	0.525	-0.257	0.376	-0.030	0.178
finger millet	-0.348	-0.308	0.430	-0.319	-0.379	0.233
teff	-0.433	0.006	0.280	-0.389	0.545	-0.165
millet	-0.065	-0.507	0.106	0.203	-0.028	0.450
chick peas	-0.073	-0.135	0.452	0.634	0.211	-0.296
faba beans	0.687	0.451	0.301	-0.175	0.143	0.061
lentil	0.732	0.400	0.209	0.031	0.081	0.049
filed pea	0.531	0.339	0.275	-0.064	0.140	0.193
vatch	0.075	-0.519	0.183	0.451	0.436	0.040
flax	0.297	0.127	0.184	0.343	-0.185	0.538
sunflower	-0.070	0.196	-0.040	0.257	-0.357	-0.422
sesame	-0.206	0.227	-0.389	-0.073	0.420	0.193
haricot beans	-0.401	0.484	-0.261	0.290	0.059	0.101
% of Variance loaded on factors (Extraction Sums of Squared Loadings)	20.14	12.31	10.04	8.58	7.53	6.67

Note: Extraction Method: Principal Component Analysis

In table 9 and 10 we present the analysis for livestock activities present in the community level survey.
About 25% of the households have no oxen, 40% have one oxen, 25% have two oxen and 10% have more than two oxen. The distribution of livestock indicates that there are marked differences per community with respect to livestock holdings.

Table 9 Livestock

	Minimum	Maximum	Mean	Std. Deviation
no oxen	0.05	0.70	0.241	0.151
one oxen	0.10	0.80	0.422	0.156
two oxen	0.00	0.60	0.254	0.129
more than two oxen	0.00	0.50	0.095	0.098
cows	0.00	1.00	0.379	0.225
sheep	0.00	0.80	0.276	0.225
goats	0.00	0.90	0.281	0.239
beehives	0.00	0.70	0.171	0.144

Table 10 indicates that the main discriminating factor is related to oxen availability. Households with less than two oxen also keep sheep. With respect to these villages with more households with few oxen the ones with one oxen also have goats and tend to have more households with sheep. Beekeeping seems to be related to keeping cows and having no oxen.

Table10 Factor scores for livestock activities

Proportion of households with	many oxen vs few oxen and sheep	if few oxen: one ox and goats versus no oxen	cows and beehives tend to be with no oxen
no oxen	-0.465	-0.667	0.534
one oxen	-0.544	0.706	-0.153
two oxen	0.812	-0.010	-0.258
more than two oxen	0.606	-0.103	-0.373
cows	0.344	0.292	0.528
sheep	-0.535	0.433	-0.160
goats	0.380	0.583	0.370
beehives	0.291	0.186	0.660
% of Variance loaded on factors (Extraction Sums of Squared Loadings)	27.14	20.01	17.39

Note: Extraction Method: Principal Component Analysis

In Table 11 and 12 We present technology choice. Some of the technologies in the analysis are not very discriminating because they are applied by most households in most villages. Fertiliser use, livestock vaccine, crop rotations, and contour plowing are applied by more than two thirds of the households. On the opposite end herbicides, improved fallow, mulch,green manure, irrigation wellsgrass\strips and private nurseries are used by less than 5% of the households. However, these technologies seem to be concentrated in a few communities. This allows for a good analysis of the development domain dimensions determing technology choice.

Table 11: Description of technologies

proportion of farmers using	Minimum	Maximum	Mean	Std. Deviation
fertilisers	0.00	1.00	0.672	0.278
pesticeds	0.00	1.00	0.137	0.236
herbicides	0.00	0.90	0.030	0.103
improved seed	0.00	1.00	0.290	0.247
livestock vaccine	0.00	1.00	0.728	0.276
purchased feed	0.00	1.00	0.400	0.300
proportion of farmers that:				
burn to clear land	0.00	1.00	0.630	0.406
fallowed fields for more than a year	0.00	1.00	0.185	0.299
used improved fallow	0.00	0.70	0.015	0.082
rotated crops	0.00	1.00	0.864	0.248
intercropped	0.00	1.00	0.499	0.394
contour ploughed	0.10	1.00	0.957	0.126
mulched	0.00	0.50	0.006	0.051
manured	0.00	1.00	0.623	0.280
composted	0.00	0.90	0.208	0.251
ploughed in crop residues	0.00	1.00	0.072	0.206
used green manure	0.00	0.10	0.002	0.014
proportion of farmers making investments (since 1991)in:				
stone terraces	0.00	1.00	0.515	0.305
soil bunds	0.00	1.00	0.226	0.304
check dams and gully stabilizers	0.00	1.00	0.408	0.298
drainage ditches	0.00	1.00	0.148	0.297
irrigation wells	0.00	0.50	0.009	0.053
irrigation canals	0.00	1.00	0.241	0.314

grass strips	0.00	0.50	0.013	0.066
tree planting	0.00	1.00	0.575	0.364
live fences	0.00	1.00	0.412	0.324
private nurseries	0.00	0.10	0.001	0.010

Table 12 factor scores for technology choice

	mulch versus manure	mulch versus drainage ditches and gully stab.	Erosion management and live fences, tree planting and intercropping.	high cost inputs and investments (contour plowing)	soil bunds and seeds
proportion of farmers using					
fertilizers	-0.141	0.221	-0.263	0.405	0.261
pesticides	0.23	-0.145	-0.075	0.261	0.161
herbicides	0.55	0.631	0.255	0.173	-0.07
improved seed	0.212	-0.179	-0.014	0.423	0.429
livestock vaccine	0.103	-0.195	-0.06	0.491	0.037
purchased feed	-0.258	0.306	0.118	0.528	-0.365
proportion of farmers that:					
burn to clear land	0.3	-0.133	-0.315	0.125	-0.102
fallowed fields for more than a year	-0.185	0.128	-0.364	0.148	0.364
used improved fallow	-0.213	0.309	0.096	0.251	0.304
rotated crops	-0.136	0.364	-0.31	-0.186	0.135
intercropped	-0.282	0.054	0.617	0.081	0.206
contour ploughed	-0.086	-0.205	-0.36	0.523	-0.282
mulched	0.49	0.723	0.205	0.132	-0.054
manured	-0.593	0.325	-0.14	0.113	-0.144
composted	-0.638	0.118	0.348	0.127	0.19
ploughed in crop residues	0.421	0.083	0.383	-0.045	0.097
used green manure	0.406	0.67	0.121	-0.036	-0.066
proportion of farmers making investments (since 1991)in:					
stone terraces	-0.373	0.197	0.088	-0.33	-0.274
soil bunds	-0.006	-0.148	0.436	-0.114	0.481
check dams and gully stabilizers	0.098	-0.438	0.481	-0.099	-0.345
drainage ditches	0.457	-0.418	0.331	-0.043	0.234
irrigation wells	0.332	0.084	-0.016	0.128	0.185
irrigation canals	0.363	-0.312	0.082	0.468	-0.327
grass strips	-0.03	0.217	0.27	-0.016	-0.291
tree planting	-0.346	-0.049	0.41	0.59	0.043
live fences	-0.305	-0.118	0.541	0.094	-0.192
private nurseries	0.178	-0.096	-0.089	0.149	-0.307
loadings	10.96	9.79	9.02	8.05	6.31

Table 12 (cont.) factor scores for technology choice

	vaccinations	contour plowing	minus pesticides	well irrigation	burning of crop residues
proportion of farmers using					
fertilizers	-0.262	0.085	0.359	0.133	0.098
pesticides	-0.369	0.125	-0.38	0.165	0.446
herbicides	0.089	0.148	0.061	0.089	0.094
improved seed	-0.248	-0.122	0.038	0.36	-0.177
livestock vaccine	0.531	-0.084	-0.115	0.23	0.008
purchased feed	-0.036	-0.276	-0.123	-0.007	0.134

proportion of farmers that:					
burn to clear land	0.336	0.278	0.157	-0.227	0.344
fallowed fields for more than a year	0.318	-0.279	0.128	-0.305	-0.086
used improved fallow	0.312	-0.407	0.168	-0.288	0.129
rotated crops	-0.131	0.116	0.467	0.041	0.081
intercropped	-0.13	0.158	0.064	-0.277	0.204
contour ploughed	0.081	0.49	0.007	0.001	-0.137
mulched	0.177	0.104	-0.075	0.081	-0.075
manured	0.116	-0.064	-0.396	0.02	-0.081
composted	0.131	0.24	0.12	0.179	0.063
ploughed in crop residues	-0.197	-0.327	0.012	0.054	0.286
used green manure	0.156	0.064	-0.166	0.037	-0.112
proportion of farmers making investments (since 1991)in:					
stone terraces	-0.149	-0.312	0.138	0.365	0.013
soil bunds	0.236	0.333	0.051	0.189	0.12
check dams and gully stabilizers	0.309	-0.189	0.185	0.122	-0.074
drainage ditches	0.068	-0.092	-0.071	-0.3	-0.117
irrigation wells	-0.127	-0.022	0.211	0.089	-0.626
irrigation canals	-0.179	-0.13	0.161	-0.114	-0.021
grass strips	-0.33	0.275	0.164	-0.449	-0.123
tree planting	-0.254	-0.097	-0.069	-0.157	-0.141
live fences	0.211	0.234	0.178	0.198	-0.098
private nurseries	0.044	-0.177	0.473	0.134	0.278
loadings	5.48	5.06	4.52	4.31	4.2

In Table 13 and 14 we present information on credit use. The most important sources of credit are friends and REST followed by the bureau of agriculture. Money lenders seem to play a role in some communities.

Table 13: description of credit use

Proportion of households borrowing from:	Minimum	Maximum	Mean	Std. Deviation
Friends	0	1.00	0.568	0.431
REST	0	1.00	0.450	0.301
Bureau of Agriculture	0	1.00	0.236	0.347
Regional Womens Association of Tigray	0	0.10	0.001	0.010
money lender	0	0.70	0.042	0.117
private trader	0	0.10	0.001	0.010
Equib group credit	0	0.15	0.003	0.018

The factor analysis clusters credit sources into three groups. The first is development-oriented credit available from REST and the Bureau of Agriculture. The second is credit from friends with the note that when credit is obtained from women's association, money is generally not borrowed from friends. The third factor is commercial credit available from money lenders and traders.

Table 14: factor scores for credit use

proportion of households borrowing from	rest and bofa	friends vs womens associations	money lenders and traders
friends	0.212	0.674	0.235
REST	0.540	0.302	-0.271
Bureau of Agriculture	0.655	-0.404	0.228
Regional Women's Association of Tigray	0.239	-0.605	-0.116
money lender	-0.370	0.171	0.561
private trader	0.410	-0.041	0.733
Equib group credit	0.424	0.432	-0.279
% of Variance loaded on factors (Extraction Sums of Squared Loadings)	18.65	18.45	16.06

Note: Extraction Method: Principal Component Analysis

In table 15 and 16 we present some development indicators extracted from the survey data. In general welfare indicators have improved over the past decade as perceived by the households except for the cost of living.

Table 15 development indicators in terms of change since 1991

change in welfare indicators since 1991	Minimum	Maximum	Mean	Std. Deviation
wealth level	1	5	3.07	1.008
availability of adequate food	1	5	2.94	0.708
Health	1	5	3.68	1.072
nutrition in children	1	5	3.04	0.425
infant mortality	0	5	4.34	0.768
ability to cope with drought	1	5	3.27	0.839
availability energy sources for heating and cooking	1	3	2.59	0.637
availability energy sources for lighting	0	5	3.19	0.692
availability of consumer goods	2	5	4.11	0.751
cost of living	1	3	1.50	0.611

The factor analysis clusters some of these indicators together into four broad categories. The first relates to wealth and access to food, which can be termed food security. The second relates to health in general, infant mortality and sources of energy for cooking, which probably decreases the incidence of some diseases. The third juxtaposes the availability of energy sources for lighting to those for cooking and heating. The last one indicates that the ability to cope with drought is threatened by the indicator for the cost of living.

Table 16 Factor scores for welfare and development indicators

change in welfare indicators since 1991	Food security	Health	Light versus cooking energy	cost of living threatens drought coping
Wealth level	0.731	-0.283	0.312	0.184
availability of adequate food	0.857	-0.064	0.312	-0.063
Health	0.201	0.630	0.168	0.378
nutrition in children	0.529	0.356	0.254	-0.142
infant mortality	0.001	0.773	0.072	0.198
ability to cope with drought	0.557	0.169	-0.188	-0.616
availability energy sources for heating and cooking	0.082	0.618	-0.508	0.029
availability energy sources for lighting	-0.470	0.180	0.719	0.109

availability of consumer goods	-0.335	0.108	0.481	-0.449
cost of living	0.265	-0.295	-0.071	0.602
% of Variance loaded on factors (Extraction Sums of Squared Loadings)	23.11	17.47	13.39	11.96

8 Results: Development pathways

Analysis of the relationship between these factors pertaining to livelihood strategies and the dimensions of development domains is an indicator of the possibility of using this type of methodology for determining development pathways. We use *seemingly unrelated regression* (SUR)[1] to estimate the relationship between the endogenous and exogenous variables. We show the results using two different sets of independent variables. First we include the two institutional factors that are independent of development domains. The results are summarized in Table 17. Then we exclude those factors to use the pure development domain dimensions, see Table 18.
In this analysis only those factors related to livelihood strategies and development pathways are included that had an adjusted R^2 higher that 5% to exclude high risk of spurious correlation. Some interesting results appear from this analysis.

The main cropping systems distinction accounting for 20% of the variance in data in community survey (see Table 8) is explained for 58% by the development domain dimensions. The most important dimension is altitude with in second place rainfall. A third significant factor is availability of credit by the Bureau of Agriculture and livestock promotion schemes. The rationality is this factor is not very clear. A comparison of Table 17 and 18 indicates that only 1% of the relationship is explained by this factor.
The second important cropping systems factor accounting for 12% of the variance is explained for 26% to 27% by the development domain dimensions. Rainfall is the dominant dimension and market access is a secondary dimension.
The maize, finger millet chickpea system accounting for 10% in the variance in the data is explined for 13% with institutional factors and 14% without institutional factors. In both cases rainfall is the dominant dimension and population density a secondary dimension.
The teff vatch sesame system accounting for 7.5% of variance is explained by 9% to 11% by the development domain dimensions. Market access is the important dimension for this system, followed by population density and rainfall.

Moving on to livestock activities we find some important differences between the analysis with and without institutional factors. The distinction between systems with many and few oxen accounting for more than one quarter of the variance in the data (see Table 10) can be explained for 24% to 25% by development domain dimensions. Systems with many oxen tend to be in more remote high rainfall, low elevation areas while systems with few oxen are closer to markets in dryer higher altitudes.

Table 17 summary of the relationship between factors of livelihood strategies and development domain dimensions.

cropping patterns

[1] The seemingly unrelated regression method (SUR) applies to a system where each equation has an endogenous variable on the left side and only exogenous variables on the right side. As in the standard regression case, the disturbances are assumed to be uncorrelated with the exogenous variables. Each equation of this kind of a system could be estimated by regression, equation by equation. However, if the disturbances of the equations are correlated, the SUR estimator is more efficient, because it takes account of the entire matrix of correlations of all of the equations. The SUR estimator minimizes the determinant of the covariance matrix of the disturbances.

	barley wheat faba lentil pea system vs sorghum teff haricot	sorghum haricot system versus millet vatch	maize finger millet chick pea system	teff vatch sesame
constant	-0.002	0.08	-0.009	-0.037
market access	0.06	0.290 ***	-0.165	-0.348 ***
population density	0.03	-0.162	0.207 **	0.281 **
Rainfall	-0.229 ***	0.464 ***	0.416 ***	0.199 **
degradation level	-0.099	0.021	0.096	0.076
soil quality	0.03	0.089	0.049	-0.066
elevation	0.772 ***	0.004	-0.108	-0.164
cooperatives	-0.056	0.063	0.122	0.006
Livestock promotion and presence of bureau of Agr.	0.138 **	0.014	-0.007	0.051
adjusted R2	0.58	0.26	0.13	0.09

	livestock activities	
	many oxen vs few oxen many sheep	cows and beehives tend to be with no oxen
constant	-0.078	0.011
market access	0.283 ***	0.208 *
population density	-0.084	0.392 ***
Rainfall	0.325 ***	-0.037
degradation level	-0.084	-0.096
soil quality	0.105	-0.319 ***
elevation	-0.322 ***	-0.18
cooperatives	0.137	-0.101
Livestock promotion and presence of bureau of Agr.	0.034	-0.062
adjusted R2	0.24	0.17

	technology choice				
	Erosion management and live fences, tree planting and intercropping.	high cost inputs and invest-ments	soil bunds and seeds	Vaccina-tions	contour plowing
constant	-0.014	0.094	-0.092	0.005	0.105
market access	-0.118	-0.033	-0.258 **	-0.03	-0.121
population density	0.039	0.168 *	0.026	-0.362 ***	0.213 **
Rainfall	0.026	-0.239 ***	-0.225 **	-0.037	-0.045
degradation level	0.121	-0.305 ***	-0.309 ***	-0.065	0.045
soil quality	0.392 ***	0.075	0.037	0.401 ***	0.115
elevation	0.140	0.001	-0.058	0.061	-0.048
cooperatives	-0.321 ***	-0.093	0.067	-0.017	0.101
Livestock promotion and presence of bureau of Agr.	0.053	0.181 **	0.092	-0.09	-0.201 **
adjusted R2	0.27	0.21	0.13	0.14	0.09

Note: *** 1% significance level, ** 5% significance level, * 10% significance level

The system with cows and beehives that is linked to households with no oxen shows a difference between the two analyses. Where both indicate that this system belongs to densely populated areas with poor soils and poor market access, the analysis without two institutional factors also indicates that lower altitudes play a role.

Table 18 summary of the relationship between factors of livelihood strategies and pure development domain dimensions.

	cropping patterns			
	barley wheat faba lentil pea system vs sorghum teff haricot	sorghum haricot system versus millet vatch	maize finger millet chick pea system	teff vatch sesame
constant	-0.01	0.08	-0.004	-0.042
market access	0.049	0.283 ***	-0.175	-0.355 ***
population density	0.042	-0.162	0.200 **	0.288 **
rainfall	-0.213 ***	0.467 ***	0.415 ***	0.207 **
degradation level	-0.095	0.023	0.1	0.078
soil quality	0.015	0.08	0.04	-0.077
elevation	0.767 ***	0.016	-0.082	-0.164
adjusted R2	0.57	0.27	0.14	0.11

	livestock activities	
	many oxen vs few oxen many sheep	cows and beehives tend to be with no oxen
constant	-0.06	0.018
market access	0.268 **	0.224 **
population density	-0.115	0.381 ***
rainfall	0.317 ***	-0.051
degradation level	-0.073	-0.1
soil quality	0.11	-0.291 **
elevation	-0.271 ***	-0.195 **
adjusted R2	0.25	0.18

	technology choice					
	mulch versus manure	Erosion management and live fences, tree planting and intercropping	high cost inputs and invest-ments	soil bunds and seeds	Vaccina-tions	burning of crop residues
constant	0.026	-0.024	0.088	-0.094	0.002	-0.013
market access	0.004	-0.096	-0.045	-0.274 ***	-0.019	0.172
population density	-0.132	0.055	0.175 **	0.028	-0.356 ***	0.317 ***
rainfall	0.194 **	0.029	-0.222 ***	-0.214 **	-0.043	0.18 **
degradation level	-0.151	0.114	-0.298 ***	-0.302 ***	-0.071	0.058
soil quality	0.162	0.414 ***	0.065	0.019	0.406 ***	-0.042
elevation	0.171	0.078	-0.001	-0.038	0.044	0.16
adjusted R2	0.07	0.2	0.18	0.14	0.16	0.11

Note: *** 1% significance level, ** 5% significance level, * 10% significance level

In technology choice a marked difference between the two analyses occurs. Not all technology sets we distilled from the community survey (see Table 12) meet the 5% criterion so different technology sets appear in each analysis.

Four technology sets are in both analyses. Erosion management with a factor loading of almost 10 (10% of variance explained by this factor, see Table 12) is explained by 20% to

27% by development dimensions (primarily occurs on good soils). The 7% difference is linked to the absence of cooperatives. Again this is difficult to explain. High cost input use (factor loading of 8) is explained 18% to 21% by the development domain dimensions the 3% difference is linked to the availability of credit by the bureau of agriculture. Here for the first time the institutional dimension makes sense. Soil bunds and improved seed (factor loading 6) are explained by 13% to 14% by the dimensions related to not so degraded land, low rainfall and good market access. The dimensions good soils and low population density (14% to 16%) explain vaccinations (factor loading 5).

Contour plowing is in the analysis with institutional dimensions and is explained for 9% by high population density and the absence of credit by the bureau of agriculture. The rationality is unclear here.
In the analysis without institutional dimensions two additional technologies meet the 5% criterion. The first is the use of mulch versus manure. Rainfall explains 7% of this relationship, with high rainfall indicating more use of mulching and low rainfall more use of manure. The second is the burning of crop residues explained for 11% by development domain dimensions higher population density and to a lesser extent by higher rainfall.

The use of credit is definitely an endogenous variable of household livelihood strategies. It can be linked to development domain dimensions and to institutional dimensions. The same holds true for development indicators. In this case we opt to use all the institutional factors we extracted from the survey. We use *seemingly unrelated regression* to get a handle on these issues. Using the 5% criterion we exclude two development indicators namely the factor related to *food security* and the factor related to *cost of living threatens drought coping* (see Table 16). All three factors pertaining to credit use are included in the analysis. The results are presented in Table 19.

Health indicator is explained for 25% by the dimensions, especially the institutional factors. Irrigation institutions have a negative impact on the health indicator. This can be explained by the fact that irrigation institutions occur where there are major irrigation schemes. Irrigation schemes tend to foster malaria. Health also improved in lower rainfall areas, on poor but not so degraded soils. Improvement in energy availability for lighting is also linked to irrigation and livestock improvement and credit from Bureau of Agriculture, where cooperatives are positively related to improvement in energy availability for cooking. The improvement in lighting energy sources is linked to better market access and higher elevation areas, while the opposite holds for improvement in cooking energy sources.

The use of credit coming from REST and the bureau of agriculture is positively related to irrigation, the availability of this type of credit. The development domain dimensions linked to this type of credit use are denselt populated, lower rainfall areas, with not so much degradation. The use of credit by women's associations is linked to irrigation, good soils and higher rainfall. The use of credit from money lenders and traders is linked to the availability of this type of credit, to irrigation, presence of cooperatives and the availability of credit from the Bureau of agriculture and livestock improvement. The only development domain dimension that plays a role here is low population density.

Table 19: development indicators and credit use

	development indicators		credit use		
	health	light versus cooking	rest and bofa	friend vs womens associations	money lenders and traders
constant	0.132 **	0.014	0.009	0.085	0.013
irrigation	-0.231 ***	0.333 ***	0.303 **	-0.27 **	0.285 ***

coops	0.095	-0.286 ***	-0.076	0.052	0.459 ***
Livestock improvement and credit by Bureau of Agr.	-0.161 **	0.181 **	0.333 ***	-0.072	0.374 ***
rest versus commercial credit	-0.047	-0.11	0.227 **	-0.188	-0.33 ***
market access	0.008	-0.218 **	-0.067	0.111	-0.033
rainfall	-0.131 **	-0.157	-0.197 **	-0.238 **	-0.094
degradation level	-0.198 **	-0.164	-0.185 **	-0.122	-0.106
good soils	-0.181 **	0.118	-0.009	-0.236 **	-0.092
elevation	0.047	0.272 **	-0.054	0.041	-0.053
population density	0.053	-0.034	0.218 **	-0.046	-0.157 **
adjusted R2	0.25	0.17	0.20	0.11	0.49

9 Results: village stratification

For the development domains we have six dimensions: market access, population density and four dimensions for agricultural potential: altitude, rainfall, soil quality and degree of degradation. Stratifying communities into specific development domains implies making divisions. In graphs 1, 2 and 3 the dimensions are plotted.

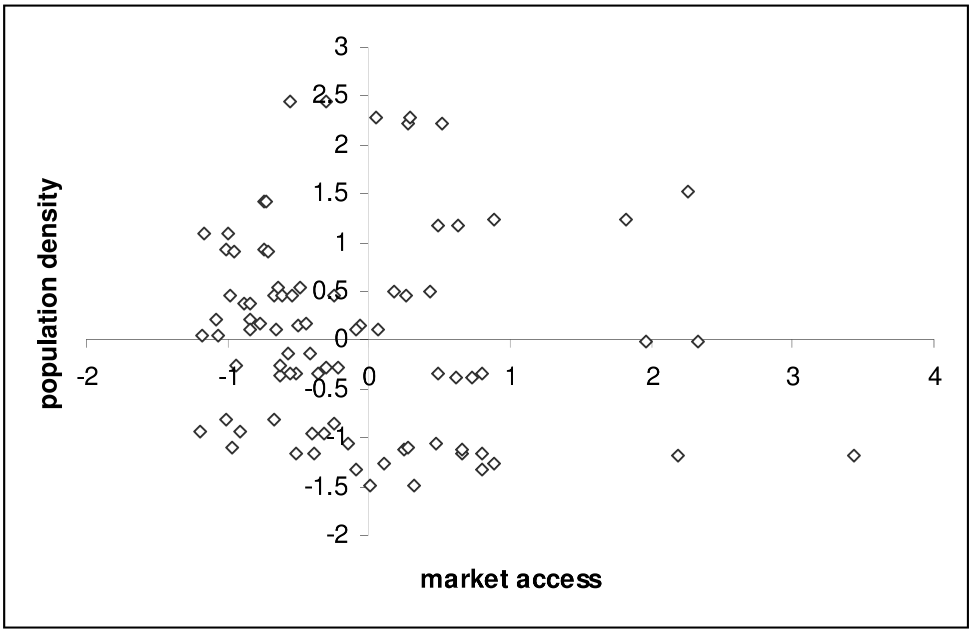

Figure 1: development domain dimensions: population density and market access

Looking at Figure 1 we see quite some differences in market access and population density. Although there is not a very strict division and the graphical presentation indicates a sliding scale the data does not concentrate in the center.

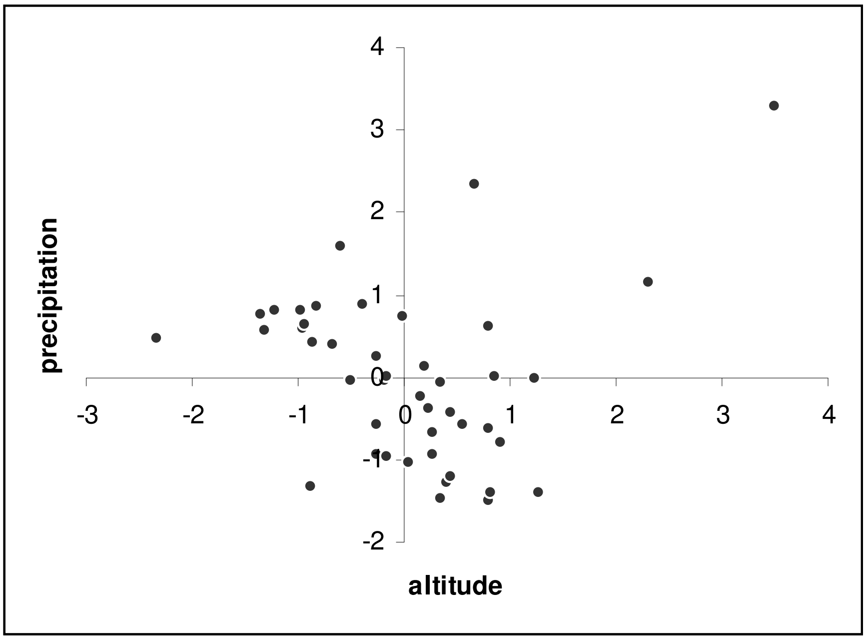

Figure 2: development domain dimensions: altitude and percipitation

Figure 2 indicates basically three situations. Low altitude high rainfall, high altitude low rainfall and a few cases of high altitude high rainfall. Of course one should take into account that the rainfall still only ranges from 475 mm to 770 mm per annum. Altitudes range from 1500 to over 3000 meters above sea level.

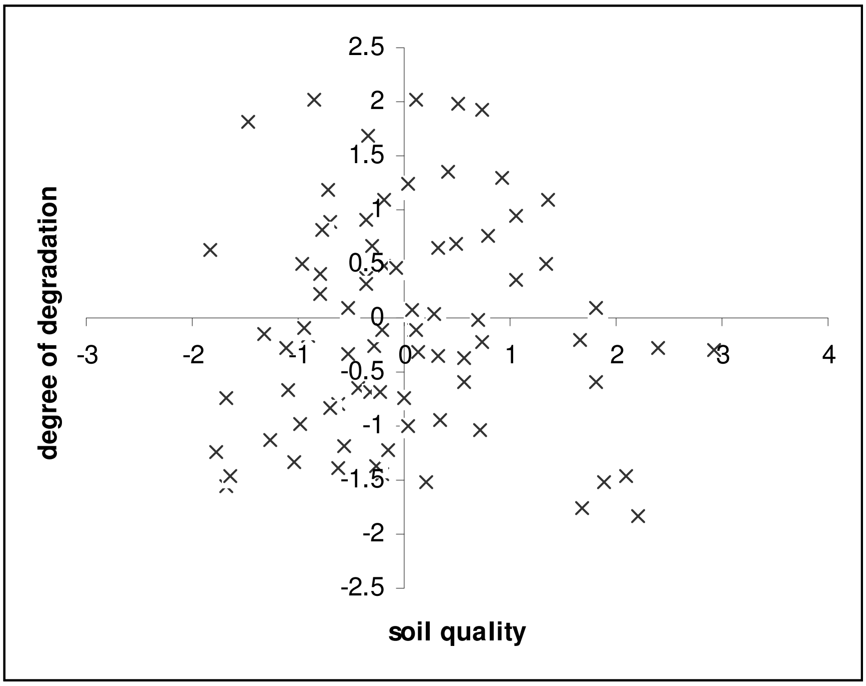

Figure 3: Development domain dimensions: soil quality and degree of degradation

Figure 3 indicates a very even distribution of soil quality indicators over the communities. Combinations of all types exist.
If we combine all the information we have 45 villages out of 85 with no missing data that can be classified into one of eight development domains, see table 20. To classify the communities we use the factor scores on the dimensions and exclude the ones close to zero. In

the case of agricultural potential we a weighted average of rainfall, soil quality and degree of degradation to determine overall potential. The weights used were 1 and –1 to indicate how the factor scored on agricultural potential.

Table 20 stratification

market access	population density	agricultural potential	
		low	high
Low	low	6	6
	high	4	3
High	low	6	4
	high	7	9

The communities in table 20 are distributed fairly evenly over high and low altitude areas, only the low market access high, population density and low agricultural potential is concentrated in the high altitude areas.

10 Policy implications

The analysis using a quantified methodology for determining development domain dimensions and linking this to data concerning livelihood strategies produces important insights that are of importance to policy makers. Besides reproducing common knowledge that serves as a check on the methodology itself it gives insight into the different ways predominant livelihood strategies depend on development domain dimensions.
Using the data in the community survey it was possible to extract the dimensions of the development domains. We are able to distinguish between market access, population density and agricultural potential. Agricultural potential is by far the most complicated dimension because it is multi-dimensional. In the present analysis we use rainfall, soil quality, and the degree to which soils are degraded as indicators of agricultural potential. In addition there is the neutral dimension of altitude that needs to be taken into account because it determines the types of crops available for the agricultural system.

We were able to determine the relative independence of the development domain dimensions. The degradation level depended for less than 1% on rainfall, population density is correlated very slightly with soil quality and market access depends for less than 4% on altitude. The R^2 is so low that we can safely ignore these interdependencies in our further analysis.

Institutional factors may also play an important role but we need to be careful in their use. Institutional factors tend not to be completely independent from the three major dimensions. In this paper we presented results including and excluding some institutional dimensions. The results indicate that for some issues taking institutional factors into account makes sense, but not for everything. When dealing with crop choice, livestock activities and even technology choice, excluding institutional dimensions seem to give somewhat better results. Only in the case of credit source and development indicators do institutional dimensions really make a difference.

The occurrence of predominant cropping systems does not depend on soil quality or level of degradation. The most important dimensions that play a role are rainfall and altitude (temperature) that are the determinants of suitability of a certain agro-ecological zone for a certain crop. In some cases crop choice does depend on factors like population density and market access. Maize is found in more densely populated areas where otherwise sorghum would prevail. Better market access in the low altitude areas seems to favour millet production. Market access is very important in the adoption of minor cash crops.

Livestock systems show a different picture. Here poor soil quality is linked to production activities that generate secondary livestock products that can be sold (dairy products and honey). This does not require good market access.

This implies that policy interventions aimed at different development domains should be different. Areas with good market access can benefit from minor cash crops. This implies that to promote these crops, infrastructure development is a prerequisite.

Technology choice hinges heavily on soil quality and level of land degradation. The use of improved seeds depends on market access. The use of external inputs in general depends on population density. This implies that farmers are more willing to intensify in high population areas, especially if soil degradation is not yet a large problem. In general improved technology adoption is positively correlated with better soils or less degraded soils.

The policy implication that arises from this conclusion is that land rehabilitation is not something that will occur regardless of interventions. It makes sense to use public interventions to rehabilitate the land. On the rehabilitated land, farm households will be more capable and willing to do necessary investments to improve production and productivity.

There is a strong link between credit availability and its use. Formal credit from development agencies tends to coincide with less degraded areas. Since there is no policy to provide credit especially to the better-endowed areas, we must conclude that credit demand is higher in better endowed areas. Since credit is instrumental in improving production and productivity we can again conclude that land rehabilitation is a public good.

The results in this paper are promising. Using community level surveys and asking for general questions that are an indication of the predominant of development pathway in terms of the livelihood strategies of community members it is possible to extract tendencies that are linked to specific development domains. While the methodology in it self is robust, further research can be used to fine tune the outcomes, in order to use them for policy recommendations. The outcomes of this stratification can also be used for developing bio-economic models and as an additional input into econometric analysis of household survey data.

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