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Development Domains for Ethiopia: Capturing the Geographical Context of Smallholder Development Options

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ABSTRACT

The choices that smallholder farmers are able to make are strongly conditioned by the geographic conditions in which they live. The importance of this fact for rural development strategy is not lost on policy makers. For example, the government of Ethiopia frequently frames policy discussions by broadly different geographical conditions of moisture availability, recognizing moisture reliable, drought prone and pastoralist areas. These conditions are seen as important criteria for determining the nature, extent and priority of development interventions for different parts of the country. There is considerable evidence, however, that other geographical factors also have important implications for rural development options. This paper uses agroecology, access to markets, and population density to define development domains: geographical locations sharing broadly similar rural development constraints and opportunities.

Unlike similar efforts conducted elsewhere, this work is unique in that it seeks to move away from a subjective mapping of factors of theorized importance to a more rigorous definition of development domains on the basis of quantitative data on smallholder livelihood strategies. After selecting variables for mapping, we calibrate our definition for domains in such a way that their explanatory power is maximized across a range of livelihood strategies that figure in the current Ethiopian rural development discourse (market engagement, dependence upon agriculture, etc.).

We find that membership in the resulting development domains explain about 18% of the total variation in these strategies, with very high significance levels for almost all strategies. Furthermore, we find that the interaction of factors captured by domains appears to have important rural development policy implications. The fact that our analysis indicates not just the nature, but also the magnitude and location of these opportunities, indicates an important advantage of development domains as a policy targeting framework.

DEVELOPMENT DOMAINS FOR ETHIOPIA: CAPTURING THE GEOGRAPHICAL CONTEXT OF SMALLHOLDER DEVELOPMENT OPTIONS

Jordan Chamberlin, John Pender, and Bingxin Yu [1]

I. INTRODUCTION

Distilling Geographical Complexity

Most policy analysts – even those operating at the very broadest levels of analysis – recognize that one-size-fits-all strategies will not work for advancing development objectives at the national level. A corollary of this is that strategic objectives defined at, say, a sectoral level, will encounter different implementation constraints in different areas. An example of this would be targeting increased high-value horticultural production by smallholders: availability of inputs, supplemental irrigation, electricity, credit, sufficient surplus labor and access to output markets are important factors affecting both the general likelihood of success as well as the identification of policy instruments for addressing specific constraints to success. Given that these factors vary considerably over space, the merits of a spatial framework for their evaluation begin to become apparent.

Policies for funding and managing agricultural R&D, extension, coordinated production and marketing strategies, and food-security interventions are mediated and transformed into action by targeted interventions. Due in part to the increased availability of spatial information on targeting indicators, there is growing recognition that spatial characterization can provide useful guidance for investment planning and implementation.

The geographical area for which national policies must be relevant in Ethiopia is extraordinarily complex. Ethiopia's 71 million people are spread non-uniformly across

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approximately 1.13 million square kilometers: from densely populated highlands (about 35% of total land area) to sparsely populated lowlands. Some 60 million rural people pursue predominantly agricultural livelihood strategies under conditions that vary widely in terms of moisture, temperature, disease, land quality and availability, remoteness from markets and services, etc. This translates to high variability in the farming systems and livelihoods pursued in different parts of the country.

However, agricultural productivity tends to be low in most areas, even compared to other sub-Saharan African countries (Dercon 2000; Yu 2005). It is likely linked to problems of poverty and food insecurity. Agricultural practices in many areas are low-input and associated with land degradation. In the highlands, most smallholder households have incomes of less than $1 per person per day and farm sizes of less than 2 hectares (Woldehanna and Alemu 2003; Pender et al. 2001a; Desta et al. 2001; Hagos et al. 1999; von Braun et al. 1998). One of the big questions of concern to policy makers is *how to get agriculture going*. In other words, how can investments be targeted to maximize rural growth taking into consideration the vast diversity of development attributes in the country?

In order to effectively address the rural growth issue, policies and investment strategies must be able to take root in a landscape of diverse biophysical and socioeconomic endowments. From an agricultural development perspective, absolute and comparative advantages of different communities are fundamentally important frames for designing development strategies. Many studies of the impacts of different kinds of investments in east African highland production systems have shown the importance of biophysical and socioeconomic contexts for understanding impacts (Benin 2003, Benin et al. 2003, Pender et al. 2001, Pender 2004a,b; Ehui and Pender 2005; Pender et al. 2006; Kruseman et al. 2006; Place et al. 2006a,b). The importance of such contextual factors has also been shown by recent global research on farming systems (Dixon et al. 2001), and earlier farming systems research (e.g., Ruthenberg 1980; Pingali et al. 1987; McIntire et al. 1992; Tiffen et al. 1994).

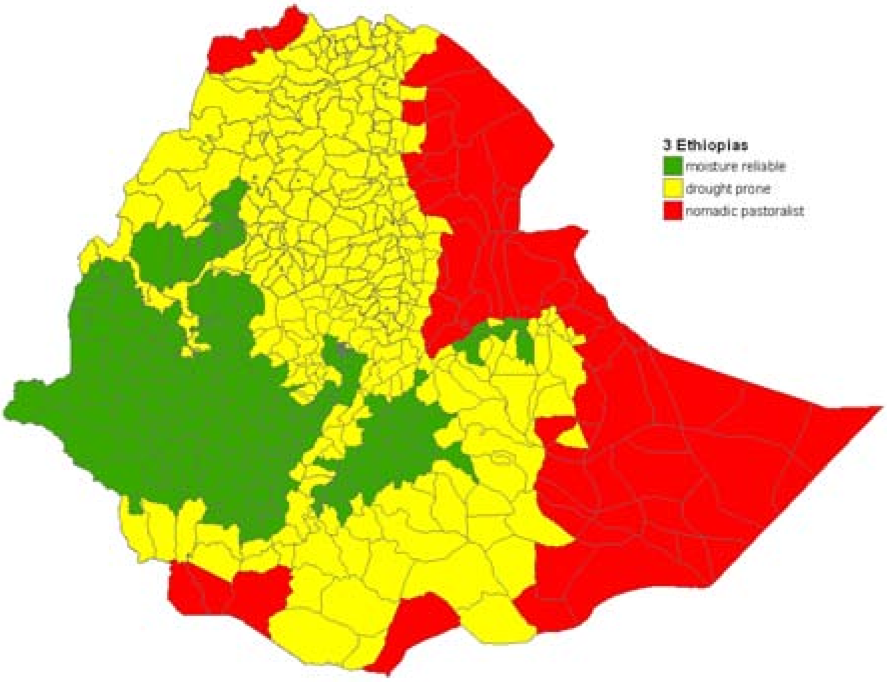
But how much heterogeneity should be addressed at strategic planning levels? If one-size-fits-all clearly does not work, neither is it possible to develop strategies for every household or community situation. In this paper we propose an approach to define agricultural development domains based on some of the key elements of diversity that determine comparative advantages of different rural livelihoods, including agricultural potential, access to markets and infrastructure, and population density (Pender, et al. 1999). While not capturing all of the factors that determine households' and communities' ability to pursue different livelihood strategies, we show that such domains can account for a substantial proportion of the variation across woredas in livelihood strategies.

Current Policy-Oriented Geographical Thinking: 3 Ethiopias

The government of Ethiopia currently recognizes a fundamental need to plan national strategies and investments within a framework that distinguishes different conditioning factors for rural development. This is made explicit through the repeated underscoring of geographical heterogeneity in strategic planning documents, such as the national Rural Development Strategy (FDRE 2001) the Sustainable Development and Poverty Reduction Program (MoFED 2002), and the Plan for Accelerated and Sustained Development to End Poverty (PASDEP: MoFED 2005). The PASDEP states that the government seeks a "geographically differentiated strategy" with different priorities articulated for different areas of the country with different needs.

However, the way that these documents recognize distinct geographical development conditions is through a relatively simple characterization. The "Three Ethiopias" are: the rainfall-sufficient highland areas, the drought prone highland areas and the pastoralist lowlands. These areas are mapped as a superset of the 18 major agroecological zones defined for the country (refined from traditional agroclimatic zones [Hurni 1986] by an FAO-led project within the Ministry of Agriculture [de Pauw 1987]).

Figure 1 shows the 3 Ethiopias as defined by the Ministry of Agriculture[2]. These areas are often a reference point for discussing different geographical priorities (e.g. promotion of industrially manufactured fertilizers in moisture reliable areas, where returns will be higher).



Note: woreda boundaries shown in grey.
Source: MoARD

Figure 1. Three Ethiopias

Implicit in the use of "Three Ethiopias" is recognition of the need to reduce geographical complexity to its most relevant elements for broadly defined objectives. Otherwise, why not use the entire set of agroecological zones, which unarguably confer much greater specificity of agroecological conditions? The point is that, as a strategic planning tool, the most important development constraints should be recognized for it to be useful for policy targeting. How well do the Three Ethiopias do that?

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[2] Partly in parallel with the use of the Three Ethiopias in strategic documents, since 1984 the national agricultural extension system has been at least nominally organized around the more explicit set of 18 major and 42 minor agroecological zones (Bonger *et al* 2004).

The concept of Three Ethiopias emphasizes moisture availability, which is widely regarded as one of the major development constraints facing smallholder agriculture. Beyond moisture reliability, however, there are additional natural and human-made geographies that are widely recognized by Ethiopian development specialists to be basic conditioning factors for rural development. The studies cited above indicate the importance of access to markets and labor, for example. Furthermore, many of the geographically-targeted goals elaborated in strategic documents (e.g. the PASDEP's prioritization of market oriented extension for "areas with potential for integration into markets", or attention to tripanosomiasis and tsetse in "[humid] low-lying areas") are not accommodated the Three Ethiopias frame.

The geography of moisture availability alone fails to capture basic patterns of either livelihood diversity in practice or of viable alternatives which may be constrained by remoteness, for example, as much or more than by moisture. The government's articulation of geographically-targeted development priorities requires a more elaborated spatial frame for analysis and planning. This paper attempts to build on the Three Ethiopias through a systematic consideration of other critical conditioning factors and their spatial expressions with the final goal of providing such a frame.

Objectives of the Present Work

We suggest that the idea of identifying basic development conditions and their spatial expression is of critical import for effectively using available resources for agricultural growth. There is often a lack of objectivity in how that is done in practice, however. If geographical planning tools leave out important factors, or if they do a poor job at representing key constraints, their value for strategy analysis is compromised.

The objectives of this paper are (a) to present a structured framework for deciding upon what kind of geographical variation to consider for understanding smallholder development options; (b) to demonstrate a method for implementing that framework, involving optimal selection of classification thresholds for a particular place and set of rural development conditions, based on available data; and (c) provide evidence of the ability of the framework to reflect key development conditions and constraints and thereby illustrate its applicability to strategic policy questions.

The subsequent sections of this paper are organized as follows. We first outline our conceptual framework, which is used to identify areas of distinctly different comparative advantages for diverse rural livelihood strategies on the basis of geographical contextual factors. We call these areas "development domains". We then describe a two-stage approach to objectively implement this framework for Ethiopia. The first stage involves expert knowledge and literature review to identify critical geographical development conditioning factors for Ethiopia. The second stage involves calibrating explicit definitions for such factors as discretely mappable domains, such that their explanatory power is maximized for a set of observed livelihood strategy indicators. We finally describe the optimized set of mapped domains for Ethiopia and discuss in detail how they may be used to guide smallholder-oriented rural development strategy.

II. CONCEPTUAL FRAMEWORK: DEVELOPMENT DOMAINS

Concept

The concept of *development domains*, as expressed in this paper, focuses on identifying mappable conditions that broadly enable (or constrain) different development options identified as nationally important. These include the relative level of agricultural endowments for rainfed (and irrigated) agriculture, access to market opportunities, and the availability of labor relative to land.

This concept developed out of work by Pender, Wood and colleagues, based on household and community level research in Uganda, Ethiopia and Honduras (Pender et al 1999, Wood et al. 1999; Pender et al. 2001a, b, c; Nkonya et al. 2004; Pender et al. 2004; Pender 2004; Pender et al. 2006a,b). Drawing upon the theory of comparative advantage and location theory (von Thunen 1826; Chomitz and Gray 1996) and the literature on evolution of farming systems in tropical agriculture (Boserup 1965; Ruthenberg 1980; Pingali et al. 1987; Binswanger and McIntire 1987; McIntire et al. 1992), Pender and colleagues proposed that general rural development options could be captured by measuring key factors that together describe the fundamental components of a given area's agricultural development endowment. These factors are *agricultural potential, access to markets* and *population density*.

Agricultural potential is the potential agricultural productivity for a variety of commodities that an area enjoys as a result of local agroecological attributes. In other words, it is a representation of an area's absolute advantage for agricultural livelihoods. Access to markets and population density translate absolute production advantages into comparative advantages for particular livelihoods. To make this clear, consider the example of an area with high rainfall, good soils, etc. as having an absolute advantage in producing high-value perishable commodities (e.g., perishable vegetables). This same area will have little comparative advantage in high-value perishables if it is distant from the nearest output markets. Population density, through its effect on local land-labor ratios, will also influence the comparative advantage of labor intensive production. At the same time, high land-labor ratios in areas with poor access to markets and low agricultural potential endowments may encourage labor-intensive but low-external input agriculture production strategies. All three factors together will influence the profitability of different commodities, production technologies and priorities, land management practices, etc.

A few important points should be made about the scope and purpose of development domains as they've been defined and used in the past, and continue to be used here. First, the conceptual model underlying development domains is oriented towards capturing the opportunities and constraints facing alternative rural livelihood options which are dependent upon agricultural production potential, labor availability and market access. Non-farm, industrial and other potential rural development pathways (not to mention urban pathways), to the extent that they are weakly linked with agriculture, are not addressed by this framework. However, in developing countries, rural development opportunities, including non-farm opportunities, are often strongly linked to agricultural development (Hazell and Ramasamy 1986; Haggblade et al. 1989; Haggblade and Hazell 1989; Hazell and Haggblade 1993).

Furthermore, in the definition of development domains that this section leads off with, "mappable" implies two important aspects of this idea. First, we are focusing on community-level or other "meso-level" (above the household but below the national level) factors (as opposed to household-level or national factors). Household characteristics, while important to many livelihood strategies, usually exhibit more variation than can be usefully captured by spatial frameworks. National factors (such as the political system and policy framework, macroeconomic conditions, etc.) by definition exhibit no variation within country and hence, for national studies, can be considered aspatial. The second point is a consequence of the first: we expect to see considerable variation at the national level in these community-level factors, and posit that this spatial heterogeneity of enabling conditions is a fundamentally important national policy analysis frame.

Another key concept embedded in the development domains idea is that of collapsing the many factors affecting multiple strategies into a relatively small set which can be said to affect most development opportunities of interest for a given set of actors (in this case, rural smallholders). It is important to recognize at the outset that no set of conditions will operate uniformly on the potential of all the development options of interest. When "zooming in" on particular opportunities, more specific factors will need to be accounted for. This movement from generalized landscapes of opportunities to specific suitability maps represents a key tension between defining general development domains and more specific recommendation domains for spatial targeting of specific interventions (which may be of more familiarity to some readers). The gains made in targeting specificity (e.g., mapping recommendation zones for sugarcane plantations) come with a consequent loss in applicability to other opportunities (e.g., intensive dairy production). Development domains, in a sense, can be seen as a first-order strategy filter, e.g., used to define overall development priorities or to assess the general magnitude of rural development gaps and opportunities. Implementing particular technologies or commodity- or variety-specific interventions would need to move beyond development domains to more specifically defined spatial targeting frames.

History and Empirical Support

The linkages between these enabling conditions and observed livelihood strategies have empirical support from a number of sources. Pender and colleagues' work in Uganda, Ethiopia and Honduras looked at the relationship between "development pathways" (common patterns of change in livelihood strategies) and observable conditioning factors such as those described above. Results from community-level surveys indicated that pathways were significantly conditioned by different community-level endowments. For example, perennial crop production was associated with higher rainfall and better market access in all three countries (Pender 2004a). Perishable annual crops production was associated with access to irrigation in both Ethiopia and Uganda (irrigation effect was not investigated in Honduras), and with higher altitudes in Honduras and Ethiopia. Non-farm and off-farm activities were associated with better access to roads and markets in all countries. Cereal and other storable annual crops were more important in lower rainfall areas in all three countries (Ibid.). The effects of population density on development pathways were less clear in these studies.

Numerous other recent studies have verified the role of agricultural potential and market access in promoting livelihoods related to high value commodity production (i.e., cash crops, dairy production, woodlots) and non-farm activities (Pender et al. 2006b; Place et al. 2006a,b; Kruseman et al. 2006; Staal et al. 2002; Holden et al. 2003; Holden et al. 2004; Nkonya et al. 2004; Jansen et al. 2003; Jansen et al. 2005a,b). Rural population pressure generally is found to have a more mixed or limited impact on livelihood strategies in these studies. For example, in the hillsides of Honduras, subsistence basic grains production and small farm sizes are more common in more densely populated communities, while livestock production is more important for larger farms (Jansen et al. 2005b). Similarly, livestock ownership is less common in more densely populated communities of northern Ethiopia (Benin et al. 2003; Kruseman et al. 2006). By contrast, population pressure was found to have limited impacts on livelihood strategies in Uganda (Nkonya et al. 2004), a positive association with woodlots and cattle density in Kenya (Place et al. 2006a) and with use of improved cattle in the northern Ethiopian highlands (Benin et al. 2003). Nevertheless, population pressure and farm size have significant impacts on the intensity of labor use and land management practices in many studies.

Another factor that can have important impacts on livelihood strategies (and which is potentially mappable) is access to rural services provided by various programs and organizations (e.g., agricultural technical assistance, input supply, credit, and marketing services provided by government programs, NGOs, and cooperatives). Several studies have shown substantial impacts of such programs and organizations on natural resource management and use of agricultural inputs (e.g., Pender et al. 2001b,c; Pender and Scherr 2002; Jagger and Pender 2003; Gebremedhin et al. 2003; Gebremedhin et al. 2004; Jansen et al. 2005b; Benin 2006; Kruseman et al. 2006; Pender and Gebremedhin 2006). However, the impacts of programs and organizations on livelihood strategies are less well-studied, in part because the presence of programs and organizations may be determined by or co-determined with livelihood strategies (e.g., coffee producer organizations develop where there is coffee production, as well as potentially contributing to coffee development) (Jansen et al. 2005b). For example, Pender et al. (2001c) found a negative association between the presence of agricultural technical assistance and non-farm development in Honduras; perhaps because such technical assistance programs invest less in communities where non-farm development is occurring. Other studies have found mixed associations of programs and organizations with livelihood strategies, with such associations being program and context-dependent (Pender et al. 2006b).

Many household level factors also can influence livelihood strategies, such as the household's endowments of natural, physical, human, financial and social capital (Carney 1998; Scoones 1998; Pender et al. 1999; Pender et al. 2006a). However, as previously mentioned, inter-household variability is difficult to represent geographically at the scale we are interested in. Furthermore, as with the presence of programs and organizations, many of these factors are also likely co-determined with or determined by the livelihood strategy pursued in a given location, limiting their usefulness as predictors of potentials of different livelihood strategies.

Policy Applications

Most of the analytical applications of development domains have focused on explicitly characterizing the location, extent and overlap of different development options and investment priorities. For example, development domains defined broadly for East Africa (Burundi, Eritrea, Ethiopia, Rwanda, Sudan, Tanzania and Uganda) served to identify priority areas for agricultural research and development investments to capture economies of scale and scope (Omamo et al. 2005). Priorities were identified for increasing productivity in agricultural sub-sectors for which poverty reduction outcomes are likely to be greatest, based on modeled growth linkages as well as spatial relationships between production and consumption.

Using quantitative spatial summary analyses of the characteristics of different production regimes has enabled quantitative evaluations of the potential economic payoffs to specific development strategies for different domains. These analyses have been carried out with multi-market models pegged to domain definitions for Ethiopia (Diao and Nin Pratt 2004) and Eastern and Central Africa (Diao 2004, Omamo et al. 2005). The importance of this for policy making has several aspects: first, the quantitative basis for modeling is improved. Second, model results are mappable and, because of this, economic forecasting is linkable with other kinds of investment analyses (e.g., spatial investment equity).

Another important policy application of domains is based on leveraging the spatially explicit nature of development options to examine the environmental corollaries of development pathways. Work in Uganda showed that certain domain-dependent pathways were characterized by practices with potential negative environmental externalities (Pender et al 2001b). For example, both cultivated area and settlements expanded most rapidly in the "cereals expansion" pathway, which was associated with lower rainfall zones and higher population density. The magnitude of the impacts of land conversion were explored by Wood et al (2001) by looking at the presence of protected areas within the domains associated with this pathway. Similarly, wetlands in traditional coffee producing areas were more likely to be drained to provide income from brick making and annual crop production. These and other findings were used to infer where potential conflicts between growth (along different development pathways) and sustainable natural resource use objectives were likely to occur. Wood et al (2001) referred to these areas as potential development "hotspots". Mapping such hotspots may be useful for identifying where development investments may have unintended consequences.

III. DEFINING DEVELOPMENT DOMAINS FOR ETHIOPIA

Description of Approach

Our approach to defining domains for Ethiopia is two-pronged. First, we aim to translate our conceptual framework in terms specific to Ethiopia and rooted in local knowledge of the development landscape. Through a consultative process[3] we have refined a core set of expert-validated ideas that guide the definition of domains most reflective of smallholder development challenges. These ideas constitute an expert consensus on what variables and category definitions result in domains that best reflect prevailing knowledge of the geographically expressed smallholder development constraints.

Second, we undertake a quantitative exploration of relationships between alternative domain definitions (i.e. different mapped implementations of the same core ideas) and a set of theorized outcomes. This work is based on statistical techniques to define domains in such a way as to maximize their explanatory power for smallholder livelihood strategies pursued in different parts of the country. The details of this work are described in full below.

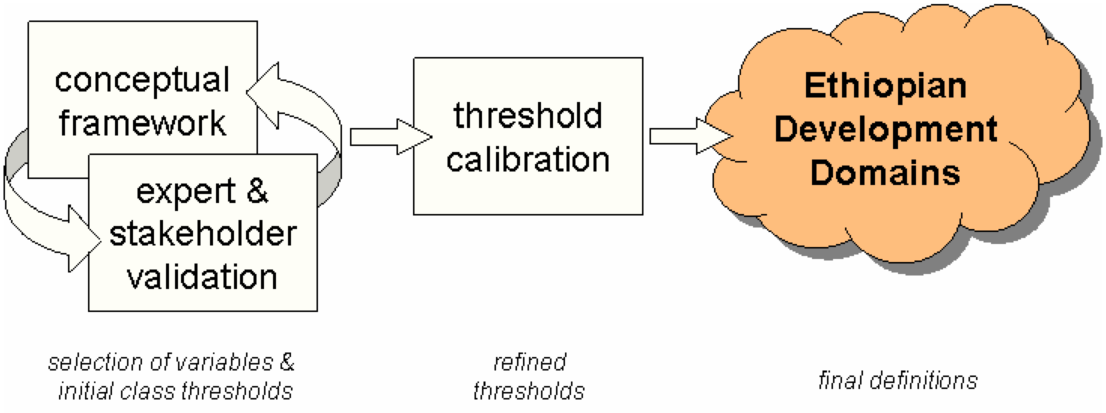

Figure 2. Approach to Defining Domains for Ethiopia

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[3] Details on this process are provided in Appendix 5.

These two approaches together are the basis for an operational set of domain definitions and subsequent analysis of the primary development options within different domains. Together this constitutes a process for domain definition, presented schematically in Figure 2.

Hierarchical Arrangement of Factors

We maintain the basic conceptual framework established by Pender et al (1999), which has already been described. That is to say, we assume that the absolute production advantages of an area are largely determined by its agricultural potential; while comparative advantages for different rural development options depend as well on different market access and population density conditions. Our definitions of these three domain components for Ethiopia are based on the following guiding principles:

- indicators used in the definition capture the most important (i.e., widely applicable) aspects of the theoretical importance of each domain component
- the inclusion of definition elements is based on their contribution of discriminatory power without adding extra complexity of ambiguous relevance
- spatially disaggregated data are available (i.e., variation at the community or higher level is observable)

In other words, our objective is to capture the greatest amount of information on differing development potentials with the least amount of unnecessary information or complexity in the domain definition. The following sections describe the rationale and evidence (where available) for each of the domain factors and their importance for smallholder livelihood options in Ethiopia. These sections are derived primarily from a review of available literature, but are also guided by ideas presented at the technical expert meetings.

Agricultural Potential

From the perspective of development opportunities, the predominant moisture availability regimes are widely perceived to present the most important dimension circumscribing agricultural potential. This makes sense, given the predominance of rain-reliant smallholder agriculture in Ethiopia. This is also consistent with the prioritization of agroclimate found in other assessments of development potential in the Ethiopian highlands (Hagos et al. 1999; Desta et al. 2001; Tefera et al. 2002). We use a combination of average annual rainfall and rainfall variability. As mentioned above, the government of Ethiopia has adopted a categorization based on broad patterns of moisture availability and reliability. But how well has this concept been implemented (i.e. how has it been mapped)? What data and threshold definitions are available for mapping these basic moisture regimes?

Existing maps of the three fundamental moisture regimes are based only on length of growing period and/or rainfall.[4] Since there was a lack of expert consensus on the resulting classifications (e.g. that some woredas looked misclassified, based on experts' knowledge of conditions), and since none of the datasets were based explicitly on reliability, we produced a new map of moisture regimes, using long-term total annual rainfall as well as long-term rainfall variability. We adjusted the definition until minimizing expert disagreement with the resulting woreda-level classification. The revised map and definition are presented in Table 1 and Figure 3, respectively.

Table 1. Revised Moisture Regime Definition ("Three Ethiopias")

Revised 3 Ethiopias	Rainfall Rules
Moisture reliable	(rain / rainCV) >= 0.1
Drought prone	(rain / rainCV) < 0.1
Pastoralist	rain < 300

***Rain**: average annual rainfall (mm); **rainCV**: coefficient of variation of avg. ann. rain*

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[4] There is some ambiguity on this, since the definitions given for Three Ethiopias did not produce the same map, when we applied them to recent datasets.

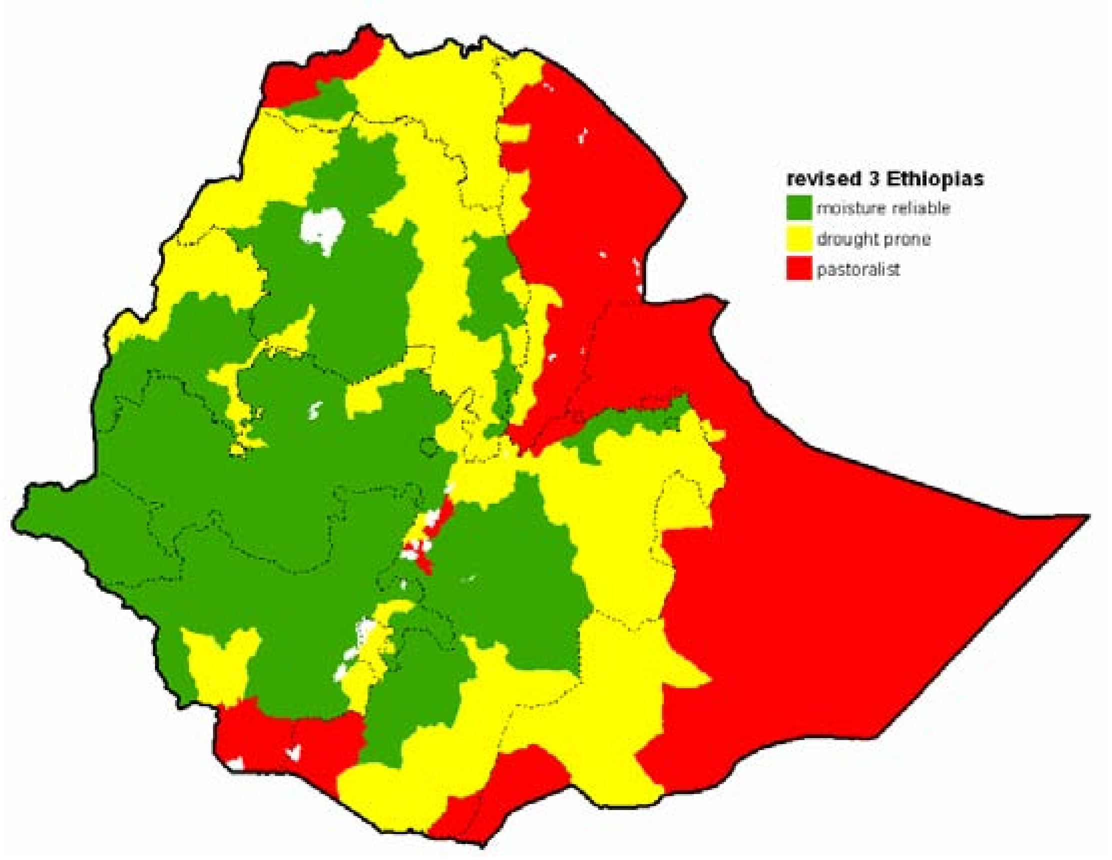

Figure 3. **Revised Moisture Regimes ("Three Ethiopias")**

In addition to better reflecting mental maps of the experts consulted concerning key agroecological conditions, the revised map performs better at predicting some outcomes than the standard definition of the three Ethiopias. One of the hypotheses underlying the use of moisture regimes as a policy-relevant analysis frame is that outcomes such as crop failure and rainfed staple yields are substantially affected by these regimes (e.g. FDRE 2001). Table 2 shows the explanatory power (adjusted R-squared values) of regressions predicting a few of these woreda-level outcome variables using the old ("standard") and our revised ("rain+CV") mapping of moisture regimes. By this criterion, the new definition is significantly better in explaining variations in outcomes than the previous one.

Table 2. Explanatory Power (adjusted R^2) of Alternative Definitions of "3 Ethiopias"[5]

	Standard	Rain+CV
frequency of severe emergency food aid, '94-'03	0.10	0.18
dominant cereal yield	0.02	0.08
ratio of local to national dominant cereal yields	0.01	0.07

However, participants in our consultative process highlighted that even at the level of very broad strategic analysis there is still a need to distinguish between highlands and lowlands within the humid and semi-humid parts of the country because of differences in climate (especially temperature) and risks of pests and diseases at different altitudes. Therefore, we further modify the moisture regime classes by introducing a distinction between highland and lowland areas. We define highlands as those areas above 1500 masl, a commonly used definition in Ethiopia (Hurni 1986, 1998; Braun et al. 1997; Hagos et al. 1999; Tefera et al. 2000; Desta et al. 2001; Pender et al. 2001b). These rules are summarized in Table 3, and the resulting classification of woredas into agricultural potential zones is shown in Figure 4.

There are certainly other factors affecting agricultural potential at the local level besides rainfall average and variation and altitude. Soil and terrain attributes, in particular, are likely to be important at the community and farm levels. But the spatial variation in these factors is at such a localized scale and the availability of data is at such a coarse scale as to render their use in domain definition difficult. Additionally, their theoretical implications for production choices are more ambiguous: for example, acidic soils may be unsuitable for wheat but preferable for coffee or tea. Although there was considerable debate, the outcome of our consultative process suggested that these factors are more important components of defining recommendation domains in targeting exercises for specific technologies, i.e., analyses subsequent to the broader strategy and investment prioritization suggested by development domain analysis in this paper.

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[5] all significant at the 0.01 level

Table 3. Agricultural Potential Zones

Agricultural Potential Zone	Rainfall Rules	Elevation (masl)
Moisture reliable highlands	(rain / rainCV) >= 0.1	> 1500
Drought prone highlands	(rain / rainCV) < 0.1	> 1500
Moisture reliable lowlands	(rain / rainCV) >= 0.2	< 1500
Drought prone lowlands	(rain / rainCV) < 0.2	< 1500
Pastoralist lowlands	rain < 300	< 1500

***Rain**: average annual rainfall (mm); **rainCV**: coefficient of variation of avg. ann. rain*

Finally, irrigation-enabled potential, while recognized as important for the country, was considered to be beyond the scope of the present exercise. The zones presented here should be understood in light of such caveats.

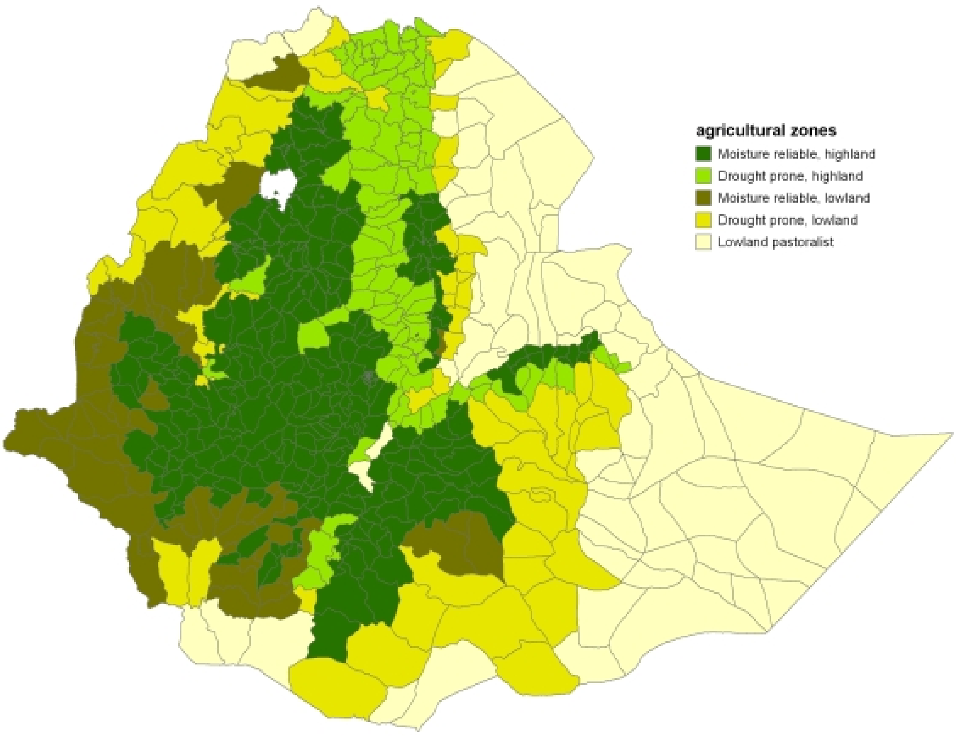

Figure 4. Agricultural Potential Zones

Access to Markets

Market access varies widely throughout rural Ethiopia. Despite agreement about the theoretical importance of market access, empirical evidence concerning its impacts is sometimes ambiguous. For example, Pender et al. (2001a) found, based on analysis of community survey data for the highlands of Tigray and Amhara regions, that better access to towns was associated with cereals-perennial production as a livelihood strategy and with better outcomes in terms of several welfare and natural resource indicators, while access to all-weather roads was found to have less significant impacts. Using the same community survey data from Tigray, Kruseman et al. (2006) conducted a factor analysis of several market access variables (distance and travel times to towns, all weather roads and bus service), and found all of these variables to be highly correlated with a single market access factor. This factor was found to be associated with significantly more production of teff (the most important cash crop in the region), less production of sorghum (subsistence crop), less ownership of livestock, but a higher indicator of household wealth (proportion of houses with metal roofs). Using household level survey data from Tigray, Pender and Gebremedhin (2006) found that access to roads and towns had significant impacts on several agricultural practices (e.g., increasing use of labor, oxen and fertilizer) and that access to towns was associated with higher crop productivity, but that neither factor was significantly associated with differences in household income. Using similar household data for Amhara, Benin (2006) found market and road access to be associated with some differences in input use and land management practices, that these impacts were different in high vs. low rainfall areas of the region, and that crop yields were higher further from roads in high potential areas (no significant effect of road or market access on yields in low rainfall areas). Thus, while market and road access are often found to have positive impacts, this is not always the case.

The multiplicity of ways in which market access can be conceptualized and translated into measurable variables may be a factor in this ambiguity. Indicators that have been used for access to markets, roads and services in different studies in Ethiopia include the distance or walking time to the nearest woreda town, market (which may be different than the woreda town), all-weather road, seasonal road, bus service, development agent, input supply shop, or grain mill; whether access to a road had improved in the recent past; whether an all-weather road passes through the woreda; and road density in the woreda (Tefera et al. 2000; Desta et al. 2001; Pender et al 2001a; Benin et al. 2003; Gebremedhin et al. 2003, 2004; Pender and Gebremedhin 2004,2006; Jagger et al. 2005; Benin 2006; Kruseman et al. 2006). But the fact is that different marketing activities take place in different locations (for example, coffee tends to be marketed through cooperatives which organize transportation from producers to city warehouses; cotton goes to ginneries, rather than market towns). So any single metric is unlikely to explain all market-driven behavior, especially across scales and farming systems.

Despite these documented complexities, our expert meetings produced some consensus that localized market access was probably of greater importance to most rural smallholders than proximity to major urban areas. Thus, smallholder-relevant domains for Ethiopia should distinguish areas of proximity to smaller urban centers and the local trade opportunities found there. Examples of these local trade opportunities include: sales of grains, root crops and other staples, limited cash crop sales (horticulture, coffee, chat), and the purchase of agricultural inputs.

There is some empirical evidence supporting these assumptions in Ethiopia. Hoddinott and Dercon (2005), for example, found that half of all input purchases and between a quarter and three quarters of grain and livestock sales were made in local market towns. In fact, for many households, these local towns were the only locations of economic exchange. They found that this local market access (as opposed to relative access to major urban centers further away) was a key factor in explaining rural purchases and sales for a variety of products, as well as total household expenditures. Although in quite a different setting, Quisumbing and Godquin (forthcoming) found evidence in the Philippines that households living closer to rural town centers are more likely to participate in groups as well as to have larger social and economic assistance networks. Similar processes may well be found in rural Ethiopia. These findings argue for an accessibility distinction to be made on the basis of smaller market towns, conceptually distinct from access to major urban centers.

This can be captured through looking at average travel time to smaller towns, rural road density, or some combination of the two. In examining potential indicators of market and road access, we considered several variables assembled at the woreda level: density of all-weather roads, density of all roads, a population- and distance-weighted attraction index, and travel time to the nearest town or city of different population sizes.[6]

Using a factor analysis of woreda-level data we found that the first factor captured most of the variance in our candidate market access variables (62% of overall variance), and this factor could be mainly attributed to the time-distance measures of access to markets (see Table 4, below). Because time to towns of 5,000 or more people had the highest factor loading, we selected this as a representative variable, i.e. a single variable that captures most of the variation in our array of market and road access indicators. This simplified the problem of selecting indicators of market and road access.

Table 4. Rotated Factor Loadings (Pattern Matrix) and Unique Variances of Market and Road Access Variables

Variable	Factor1	Factor2	Factor3	Factor4	Uniqueness
time to town of 2,000+	0.9536	-0.1745	-0.1351	-0.0946	0.0330
time to town of 5,000+	0.9645	-0.1790	-0.1462	-0.0916	0.0079
time to town of 10,000+	0.9590	-0.1869	-0.1569	-0.0836	0.0139
time to town of 20,000+	0.9407	-0.1877	-0.1872	0.0140	0.0446
time to town of 50,000+	0.9136	-0.1744	-0.2624	0.1903	0.0300
time to town of 100,000+	0.8581	-0.1972	-0.3004	0.2511	0.0715
time to Addis	0.7509	-0.1209	-0.4132	0.1219	0.2359
road density, all-weather (woreda ratio)	-0.1531	0.9121	0.1553	-0.0235	0.1200
road density, all types (woreda ratio)	-0.2196	0.8845	0.1758	-0.0018	0.1385
road density, all-weather (local filter)	-0.3218	0.5649	0.6295	0.0690	0.1763
road density, all types (local filter)	-0.5185	0.1980	0.3203	0.0987	0.5796
gravity model	-0.4088	0.3837	0.7145	-0.0576	0.1718

***Note**: Based on data for 505 woredas, detailed descriptions of these variables are provided in Appendix 3*

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[6] See Appendix 3 for a full list and description of market access indicator variables tested.

There are certainly non-physical elements of market access as well, which we do not attempt to address here. For example, market information may influence the perceived costs of market participation over and above actual transportation costs. Institutional and cultural factors likely also play a role in actual market accessibility at the community level. At the household level, of course, even more factors come into play. However, we suggest that the aspects of physical access to markets outlined above can be used to represent economically meaningful variation in accessibility.

Finally, incorporating the temporal dynamics of accessibility is another challenge. These dynamics may be regular (e.g., seasonality) or probabilistic (e.g., different degrees of stability associated with different markets). The baseline conditions under which we may trace physical access to a set of markets can be expected to change over time, which has implications for long-term policies and strategy development. For example, changes in urbanization, infrastructure development (and decay), regional trade reforms, etc. will translate into changing geographical patterns of physical accessibility to markets.

Population Density

The land/labor ratio has been theorized to have consequences for land management and other production technology strategies (see, in particular, Boserup's [1965] theory of induced innovation). As such, looking at variation in population density may be a useful organizing frame for examining some kinds of farm and land management decisions.

The most important way in which population density is expected to influence community-level development options is through enabling of labor-intensive livelihoods and land management approaches. In high density areas, for example, we would expect to see more labor intensive high-input horticulture in high potential areas with good access, and more labor intensive poultry and small ruminant production in low potential areas (Tefera et al. 2002; Pender, et al. 2006a). Higher population density may stimulate adoption of labor intensive investments in land improvement, such as terraces, or use of labor intensive land management practices, such as application of organic materials

(Boserup 1965; Tiffen, et al. 1994). Higher population density can also stimulate development of local markets, investments in infrastructure, technologies, and institutions, and nonfarm opportunities by increasing local demand, reducing transaction costs and enabling the fixed costs of such investments to be shared among a larger number of beneficiaries (Ibid.; Pender 2001).

Another important potential impact of population density, however, is pressure on land resources. For example, the need to produce food in subsistence farming areas may induce producers to forgo adequate fallow practices, cultivate on very marginal and fragile land, or overuse common property resources such as forests, grazing lands, and water sources (WCED 1987; Pender 2001). Under conditions of low input availability, such as might be expected in cash-poor or remote areas, such problems might be exacerbated. Some have argued that there could be a U-shaped response to population pressure, with more land degradation likely at intermediate population density than at low or high density, due to less pressure on resources at low densities and induced responses that lead to improved land management at high densities (Scherr and Hazell 1994; Pender 1998). Hence, it may be useful to distinguish areas of intermediate population density from those with low or high density, in considering development options and likely resource impacts.

Our expert consultations confirmed the importance of rural population density as an indicator of available labor, as well as of land pressure in Ethiopia. There was no consensus, however, on what population densities actually constituted “high” or “low” density conditions. Population estimates at the woreda level, relative to total land area, were considered adequate indicators of population density for this exercise.

Validation and Calibration of Thresholds

One of the serious challenges facing the continued use of development domains as a strategy guidance framework is the lack of objective means of calibrating the specific definitions. For example, we have both a theoretical appreciation as well as some empirical evidence of the importance of population density on development potential.

Yet, in practice, we assign an essentially arbitrary definition of “low” and “high” for characterizing different regimes of any particular factor. Furthermore, our choice of the number of classes we define (e.g. “low” and “high” versus “low”, “medium” and “high”), despite being driven by knowledge of different development conditions, is also fundamentally arbitrary.

By looking at the responsiveness of different outcomes we theorize to be linked to our domain factors, we can adjust the domain definitions to maximize their explanatory power. Here, we take the following approach: building upon a consensual definition of domain factors (as outlined above), we then optimize how they are represented and broken into categories by testing the amount of variance of key rural livelihood indicators observed within domains based on different thresholds. On this basis, we may select threshold levels that maximize the explanatory power of development domains.

Clearly, rural livelihoods are complex and not always easily represented by mappable data. Nonetheless, we identify several indicators of key aspects of rural smallholder livelihoods, all of which might be conditioned in part by community-level comparative advantages. The variables we use here are all woreda-level estimates taken from the 2001-2002 Ethiopian Agricultural Sample Enumeration. We have broken the variables into several categories:

Degree of market participation for crop production
  cereals – average share of household production marketed (%)
  pulses – average share of household production marketed (%)
  oilseeds – average share of household production marketed (%)
  vegetables – average share of household production marketed (%)
  root crops – average share of household production marketed (%)

Predominance of cash crops in production
  coffee – average share of total crop area (%)
  chat – average share of total crop area (%)
  oilseeds – average share of total crop area (%)
  vegetables – average share of total crop area (%)

Engagement in off-farm activities

- average share of population fully dependent on agriculture (%)
- average share of population dependent upon part-time agriculture (%)
- average share of population primarily dependent on non-agriculture (%)

Livestock dependence

- cattle – average herd size (# of animals per holder)
- sheep – average herd size (# of animals per holder)
- goats – average herd size (# of animals per holder)

The descriptive statistics for these livelihood strategy indicator variables (using woreda level data) are presented in Table 5. These variables are described more fully in Appendix 3 and are shown mapped in Appendix 4.

The calibration procedure entailed iterating through different domain threshold definitions, using analysis of variance at each iteration to compute the share of variance across woredas of each livelihood indicator explained by the domain categories. This calibration can be formally expressed as maximizing

$$\sum_j w_j R^2(AP_T, MA_T, PD_T)$$

where:

w_j is the weight associated with the *j*th livelihood strategy variable; and

$R_j^2(AP_T, MA_T, PD_T)$ is the share of the variance of the *j*th livelihood strategy variable explained by differences across the development domains defined by thresholds of agricultural potential (AP_T), market access (MA_T), and population density (PD_T).

Table 5. Descriptive Statistics for Outcome Variables[7]

Livelihood Strategy Variables	# of woredas	Mean	Standard Deviation	Bottom Quintile	Top Quintile
Market participation (share of sold production, %)					
Cereals	469	15.3	7.8	8.8	21.2
Pulses	469	18.7	10.6	11.3	25.0
Oilseeds	469	40.3	25.2	18.5	63.3
Vegetables	469	22.1	18.0	10.0	29.7
Root crops	469	25.4	20.4	10.0	38.3
Cash crop (share in total area, %)					
Coffee	464	3.6	8.3	0.0	2.0
Chat	464	1.3	3.8	0.0	1.0
Oilseeds	464	4.0	6.6	0.2	4.9
Vegetables	464	0.8	1.4	0.1	0.8
Employment (share in workforce, %)					
Fully dependent on agriculture	479	78.8	14.6	68.7	91.3
Part-time agriculture	479	18.2	13.1	6.8	28.2
Non-agricultural employment	479	3.0	3.8	0.9	3.3
Livestock (average herd size)					
Cattle	480	3.9	3.9	2.7	4.4
Sheep	480	1.4	3.0	0.4	1.7
Goats	480	1.6	3.4	0.4	1.6

***Source**: Ethiopian Agricultural Sample Enumeration (EASE) data for 2002/03, Central Statistics Authority*

In this calibration, we took the thresholds for agricultural potential as given, using the "five Ethiopias"shown in Table 3 and Figure 4.[8]. Given the pre-determined agricultural potential classification, we then calculated the share of variance of each livelihood strategy indicator explained (R^2 values) by the domains defined by particular thresholds of market access and population density, iterating through a set of possible thresholds for market access and population density and selecting the threshold levels with the maximum sum of R^2 values (summing across all of the livelihood strategy

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[7] Woredas with questionable data for particular variables were excluded from these statistics and from the analysis below. Many lowland woredas were not covered by the EASE data and were excluded. In addition, there were several cases in which it could not be determined whether a zero value was truly a zero or was a missing value. Such cases were treated as missing data and dropped from the analysis.

[8] The reason for this was that the multiple-indicator nature of our definition of agricultural potential does not lend itself well to an iterative investigation of thresholds. However, this exception to the general logic of the optimization work could be revised in the future, such that all inputs are subjected to the same optimization rules.

indicators). In this maximization, we weighted each of the livelihood strategy indicators equally (i.e., w_j = 1 for all j), since we had no basis to select a different weighting scheme. In future work, different weights could be selected, perhaps on the basis of a consultative process with stakeholders, with weights reflecting the importance that stakeholders place on particular livelihood indicators.

We initially performed this procedure on one livelihood strategy variable at a time, considering only one threshold for each of market access and population density. The results of these tests indicated a clustering of the optimal market access threshold at around 3 hours from the nearest town for most livelihood strategy indicators. For population density, by contrast, we found that the optimal threshold in most cases took either a low value around 40 to 50 persons per square km or a high value around 170-180 persons per square km, depending on the livelihood indicator considered. Based on these results, we decided to use two threshold levels for population density (i.e., distinguishing "high", "medium" and "low" population density) and one threshold level for market access (distinguishing "high" vs. "low" market access). Using two thresholds to define three levels of population density is also consistent with our expectations, based on the literature discussed earlier, that household responses and outcomes may have a non-monotonic relationship with population density; e.g., with better management of natural resources at either high or low population density than at an intermediate level.

We also performed a number of tests on combinations of variables, such as different indicators for market access. It was found that most reasonable results came from market access represented by mean woreda travel time to nearest town of 5,000 or more inhabitants. In order to test robustness of our calibration process, the same algorithm was applied to alternative samples based on data quality (i.e., dropping up to 16 woredas), and no significant different thresholds were found in the results.

Table 6 below summarizes the identified thresholds and explanatory power of the resulting domains for the individual livelihood strategy indicators. For most livelihood strategy indicators, the optimal market access threshold is about 3 hours to the nearest town, and the optimal population density thresholds are around 40 to 50 persons per square km for the low threshold and 170 to 180 persons per square km for the high threshold. The domains explain between 7 and 43 percent of the variance for individual livelihood strategy variables.

Table 6. Optimal Threshold Levels for Individual Livelihood Strategy Variables

Livelihood Strategy Variables	Optimal Threshold Levels for Individual Livelihood Variables Market access[1]	 Low pop density[2]	 High pop density[2]	 R-square
Market participation (share of sold production, %)				
Cereals	2.8	46	183	0.2754
Pulses	3.1	59	183	0.4020
Oilseeds	2.9	46	177	0.2818
Vegetables	2.8	41	174	0.1978
Root crops	2.8	42	162	0.2636
Cash crop (share in total area, %)				
Coffee	5.4	48	153	0.1175
Chat	2.8	42	182	0.1770
Oilseeds	4.7	50	171	0.1568
Vegetables	3.3	49	154	0.1215
Employment (share in workforce, %)				
Fully dependent on agriculture	3.7	42	183	0.4227
Part-time agriculture	3.0	38	182	0.1712
Non-agricultural employment	3.1	48	168	0.1412
Livestock (average herd size)				
Cattle	2.8	42	181	0.0852
Sheep	3.3	41	182	0.0719
Goats	2.8	38	183	0.1730

[1] *Market access threshold measured as travel time in hours to the nearest town of 5,000 or more people.*
[2] *Population density threshold is measured in persons per square kilometer.*

Assuming equal weights for all 15 outcome variables, we eventually obtained the aggregate R-square values, based on a single market access threshold and 2 population density thresholds. Not surprisingly (given the results in Table 6), aggregate R-square peaked near a small sphere centered at a market access threshold of 3.3 hours, low population density threshold of 44.4 persons per square km, and high population density threshold of 176.2 persons per square km[9].

Therefore, the final domain definitions were based on:

- ★ the five agricultural potential zones, as described above
- ★ market access was represented by mean woreda travel time to nearest town of 5,000 or more inhabitants
- ★ two classes of market access:
  - o *high market access*: less than 3.3 hours mean travel time to the nearest town of at least 5,000 persons
  - o *low market access*: greater than 3.3 hours mean travel time to the nearest town of at least 5,000 persons
- ★ three classes of population density:
  - o *high population density*: greater than 176 persons per square kilometer
  - o *medium population density*: between 44 and 176 persons per square kilometer
  - o *low population density*: less than 44 persons per square kilometer

In order to justify our calibrated thresholds, analysis of variance (ANOVA) was performed to investigate the significance of differences across the domains in outcome variables. The resulting p-values for F-statistics are reported in Table 7.

The test results indicate that differences across the defined domains are statistically significant at the 1% level for all of the livelihood strategy variables, showing that these domains are indeed reflecting significant differences in livelihood strategies.

When we look at individual factors defining domains, differences across agricultural potential zones are significant for almost all variables, except chat (and only weakly significant for vegetables). Most livelihood strategy variables in the sample are also significantly affected by differences in population density, except the share of

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[9] R-squares from combination of thresholds are ranked from high to low to scrutinize the distribution in a 4-dimensional surface. The 1000 highest R-square scores are associated with thresholds closely clustered in the neighborhood of 3.3 hours to nearest town of 5,000 or more (threshold between high and low market access), 44 persons per square kilometer (threshold between low and medium population density), and 176 persons per square kilometer (threshold between medium and high population density).

vegetables sold (and coffee production is only weakly affected by population density). Proximity to market is a highly significant determinant of production of cash crops such as coffee, oilseeds, and vegetables, the share of vegetables sold, non-agricultural employment, and goat production.

Table 7. Significance Tests for Differences in Livelihood Strategy Variables across Defined Domains (p-values)

Livelihood Strategy Variables	Market Access	Pop. Density	Ag. Potential	All Domains
Market participation (share of sold production, %)				
Cereals	0.714	0.005	0.002	0.000
Pulses	0.160	0.000	0.000	0.000
Oilseeds	0.144	0.001	0.000	0.000
Vegetables	0.037	0.119	0.092	0.000
Root crops	0.694	0.004	0.000	0.000
Cash crop (share in total area, %)				
Coffee	0.000	0.090	0.001	0.000
Chat	0.228	0.000	0.111	0.000
Oilseeds	0.003	0.000	0.000	0.000
Vegetables	0.000	0.000	0.000	0.000
Employment (share in workforce, %)				
Fully dependent on agriculture	0.418	0.001	0.000	0.002
Part-time agriculture	0.520	0.003	0.001	0.011
Non-agricultural employment	0.000	0.000	0.000	0.000
Livestock (average herd size)				
Cattle	0.221	0.000	0.000	0.000
Sheep	0.124	0.025	0.000	0.000
Goats	0.029	0.000	0.000	0.000

These results support the legitimacy of our development domain definitions. The final domain factors, their optimal thresholds and final assembly as development domains are shown in the figures below.

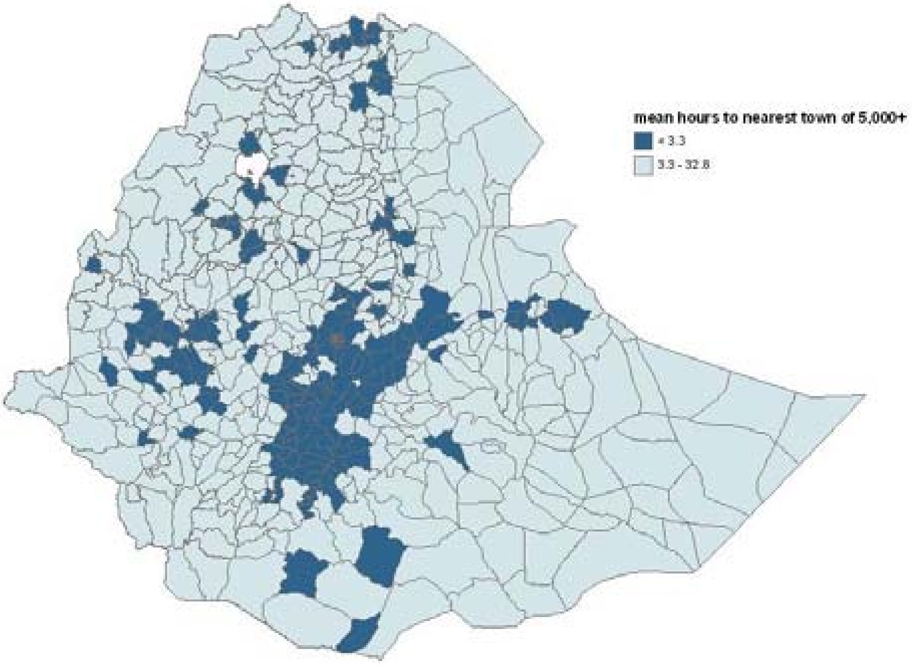

Figure 5. Selected Market Access Indicator with Optimal Threshold

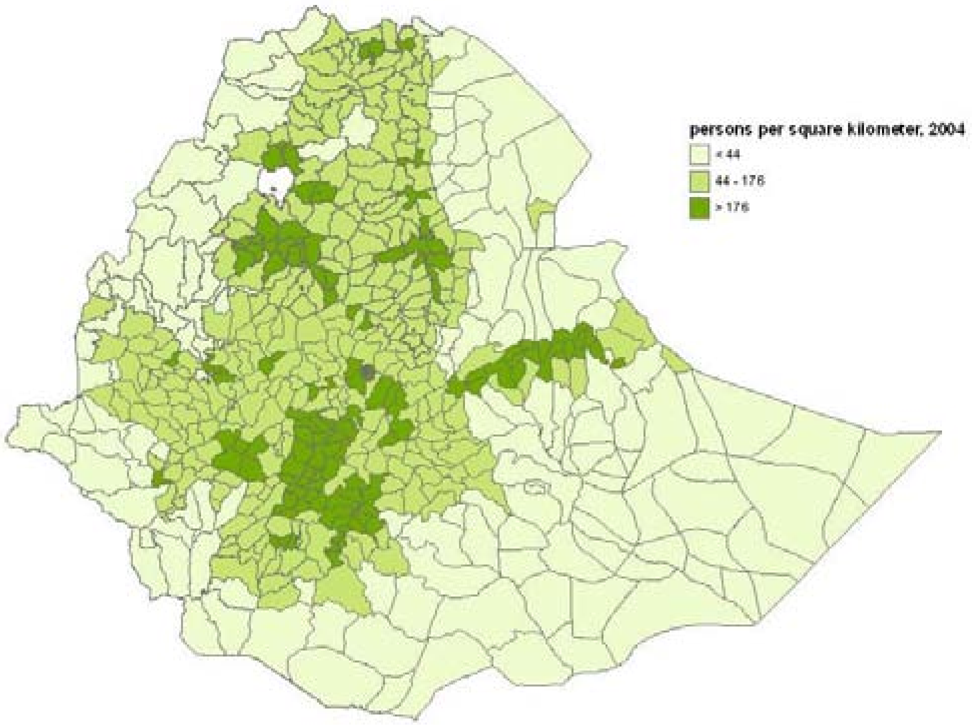

Figure 6. Population Density with Optimal Thresholds

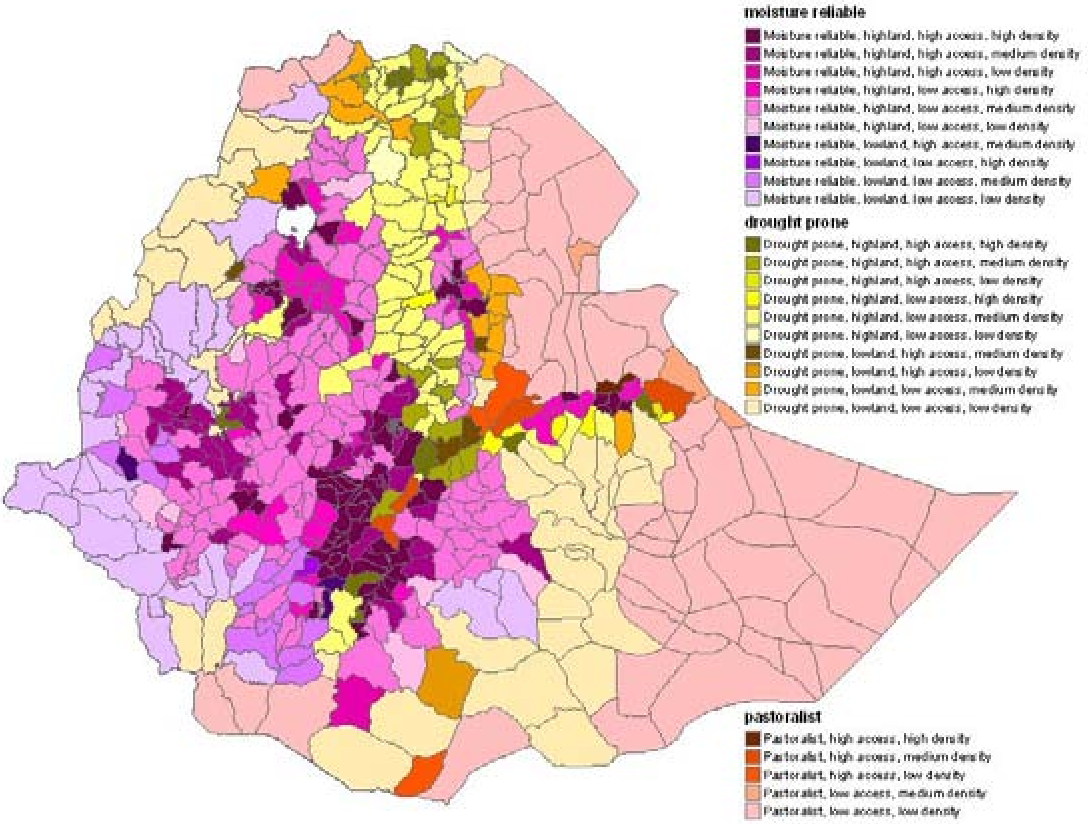

Figure 7. Development Domains for Ethiopia

IV. DESCRIPTIVE ANALYSIS OF OPTIMIZED DOMAINS

Theoretically, there could be as many as 30 domains defined by our classificication (5 zones of agricultural potential x 2 classes of market access x 3 classes of population density). However, only 25 domains were assigned to woredas due to empty sets for some of the combinations.

The 25 optimized development are shown in Figure 7 above. Some domains are quite localized, while others are fairly extensive. This section explores some of the patterns that these domains capture. We start by looking at the distribution of domains in terms of land and population. We then look at the distribution of key livelihood strategies, as measured by the same indicators used in the domain calibration. We then examine how geographical patterns of agricultural production, yields, and chronic food insecurity, play out within these domains.

Land and Population

Tables 8a and 8b provide some indication of the relative importance of different domains, in terms of the number of woredas, population and land area in each domain. Tables 9a and 9b show the same information as shares of national totals.

More than 60% of the country lives in the moisture reliable highlands.[10] This is in contrast to the share of total land area, which is much more evenly distributed between agricultural potential classes. A similar share of the total population (62%) lives in low access areas, according to the definition adopted here. While there are relatively few areas (or people) living in high-density/low-access areas, there are quite a few in medium-density/low-access areas, particularly throughout the highlands. Most of the population lives in domains with medium and high population densities, with about half

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[10] Note that total population (urban + rural) is presented in these tables. However, using estimates of rural population only, the relative shares are very similar.

of the population in medium density areas. Although the majority of the national territory is low-density, only 12% of the population lives in these areas[11].

Nationally, the greatest share of the rural population lives in high- and medium-density areas of the moisture reliable highlands and in the low-access, medium-density parts of the drought prone highlands. In terms of land area, most of the highlands consists of low-access, medium-density conditions. A large majority of land in the lowland and pastoral areas is low-access and low-density.

Table 8a. Number of Woredas, Land Area and Population by Individual Domain Dimension

Domain Factor	# of woredas	Area (km2)	Population
Agricultural Potential			
Moisture reliable, highland	303	283,149	44,224,070
Moisture reliable, lowland	58	132,923	4,056,314
Drought prone, highland	91	106,616	13,151,915
Drought prone, lowland	63	223,612	4,314,163
Pastoralist	66	382,814	5,451,226
Market Access			
high access	183	140,653	26,772,555
low access	398	988,461	44,425,132
Population Density			
high density	158	88,009	27,456,010
medium density	272	346,779	35,288,594
low density	151	694,326	8,453,083
National	*581*	*1,129,114*	*71,197,687*

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[11] The fact that a quarter of the nation's woredas, however, are located in such low-density areas raises interesting issues. For example, the fact that resource allocation in an decentralizing administrative environment must negotiate different distributions of land, populations, sectoral activities, etc, might benefit from a domains framework to inform weighting mechanisms in resource allocation. Another issue is that of the equity of issue advocacy in parliamentary and other representative governance structures. Further examination of these issues might take advantage of development domains as an analytical frame.

Table 8b. Number of Woredas, Land Area and Population by Domain

Domain	# of woredas	Area (km2)	Population
Moisture reliable, highland, high access, high density	99	42,092	16,086,704
Moisture reliable, highland, high access, medium density	39	37,309	4,324,025
Moisture reliable, highland, high access, low density	1	5,487	76,066
Moisture reliable, highland, low access, high density	38	31,042	7,302,788
Moisture reliable, highland, low access, medium density	117	150,615	15,991,329
Moisture reliable, highland, low access, low density	9	16,604	443,158
Moisture reliable, lowland, high access, medium density	3	2,717	351,824
Moisture reliable, lowland, low access, high density	1	821	187,861
Moisture reliable, lowland, low access, medium density	19	26,956	2,053,383
Moisture reliable, lowland, low access, low density	35	102,429	1,463,245
Drought prone, highland, high access, high density	12	7,456	2,240,323
Drought prone, highland, high access, medium density	15	16,210	1,875,814
Drought prone, highland, high access, low density	1	333	12,867
Drought prone, highland, low access, high density	7	5,542	1,273,530
Drought prone, highland, low access, medium density	54	72,942	7,666,335
Drought prone, highland, low access, low density	2	4,133	83,046
Drought prone, lowland, high access, medium density	4	3,743	340,265
Drought prone, lowland, high access, low density	1	7,566	149,854
Drought prone, lowland, low access, medium density	14	21,671	1,530,184
Drought prone, lowland, low access, low density	44	190,632	2,293,861
Pastoralist, high access, high density	1	1,056	364,805
Pastoralist, high access, medium density	4	8,324	756,869
Pastoralist, high access, low density	3	8,361	193,140
Pastoralist, low access, medium density	3	6,293	398,565
Pastoralist, low access, low density	55	358,780	3,737,846
National	*581*	*1,129,114*	*71,197,687*

***Source**: woreda population estimates for 2004 from CSA*

Table 9a. Shares of National Totals (%) by Individual Domain Dimension

Domain Factor	# of woredas	Area (km2)	Population
Agricultural potential			
Moisture reliable, highland	52%	25%	62%
Moisture reliable, lowland	10%	12%	6%
Drought prone, highland	16%	9%	18%
Drought prone, lowland	11%	20%	6%
Pastoralist	11%	34%	8%
Market access			
high access	31%	12%	38%
low access	69%	88%	62%
Population density			
high density	27%	8%	39%
medium density	47%	31%	50%
low density	26%	61%	12%
National	*100%*	*100%*	*100%*

Table 9b. Domain Shares of National Totals

Domain	# of woreda	Area (km2)	Population
Moisture reliable, highland, high access, high density	17%	4%	23%
Moisture reliable, highland, high access, medium density	7%	3%	6%
Moisture reliable, highland, high access, low density	0%	0%	0%
Moisture reliable, highland, low access, high density	7%	3%	10%
Moisture reliable, highland, low access, medium density	20%	13%	22%
Moisture reliable, highland, low access, low density	2%	1%	1%
Moisture reliable, lowland, high access, medium density	1%	0%	0%
Moisture reliable, lowland, low access, high density	0%	0%	0%
Moisture reliable, lowland, low access, medium density	3%	2%	3%
Moisture reliable, lowland, low access, low density	6%	9%	2%
Drought prone, highland, high access, high density	2%	1%	3%
Drought prone, highland, high access, medium density	3%	1%	3%
Drought prone, highland, high access, low density	0%	0%	0%
Drought prone, highland, low access, high density	1%	0%	2%
Drought prone, highland, low access, medium density	9%	6%	11%
Drought prone, highland, low access, low density	0%	0%	0%
Drought prone, lowland, high access, medium density	1%	0%	0%
Drought prone, lowland, high access, low density	0%	1%	0%
Drought prone, lowland, low access, medium density	2%	2%	2%
Drought prone, lowland, low access, low density	8%	17%	3%
Pastoralist, high access, high density	0%	0%	1%
Pastoralist, high access, medium density	1%	1%	1%
Pastoralist, high access, low density	1%	1%	0%
Pastoralist, low access, medium density	1%	1%	1%
Pastoralist, low access, low density	9%	32%	5%
National	100%	100%	100%

***Source**: woreda population estimates for 2004 from CSA*

Livelihood Strategies

The patterns of the livelihood strategy indicators across the development domains are more complex than expected, with a few surprising results. Variations in household market engagement across the domains are rather diffuse, but still offer some interesting observations (Table 10). The commercialization of cereals is generally higher in the moisture reliable domains than in the drought prone domains (and this difference is more pronounced in the highlands), as one would expect, although there are exceptions to this within each category. Notably, the highest commercialization rates for cereals within moisture reliable domains are in the areas of lower market access, while commercialization in other agro-ecologies is highest in high access areas. These results suggest that the impacts of market access on comparative advantages of particular livelihood strategies depend upon the agricultural potential of the area. In high potential areas, cereals are likely less profitable than higher value commodities such as vegetables in areas of high market access, but may have a strong comparative advantage in areas of low market access. In more drought prone highland areas and low rainfall lowland areas, cereals may be the most profitable and/or least risky option for farmers with relatively good market access (unless they have access to irrigation). Consistent with this explanation, in the drought prone highlands we find the highest commercialization rates for cereals in areas with favorable market access, and in the moisture reliable lowlands we find the lowest commercialization rate for cereals in areas of high access. Thus, we do not find a uniform impact of market access on cereal commercialization, as it appears to depend on the agro-ecological context.

With regard to the impacts of population density, cereal commercialization generally increases with population density across all agro-ecological zones. This finding is counterintuitive, since one would expect the potential for surplus cereal production to be greater where population density is lower within a given agro-ecological potential zone. This may reflect differences in soil quality, access to services or other factors not reflected by the domain dimensions that are relatively favorable for cereal production in areas of higher population density (such factors may be part of the reason for higher population density in certain areas). These findings emphasize that although the domain dimensions are important for determining local comparative advantages, other factors are also important.

Similar patterns are evident regarding commercialization of pulses. In the moisture reliable highlands and lowlands, the highest commercialization rates for pulses are found in areas of low market access; while in the drought prone highlands and lowlands and the pastoralist lowlands, the highest commercialization rates occur in areas of high access. Again, the impacts of market access on commercialization of a particular type of crop depend on the agro-ecological context. As for cereals, we also find generally higher commercialization of pulses in areas of medium to high population density than in areas of low density; probably for similar reasons.

Oilseed production is most common in drought prone and pastoralist lowlands, especially in areas of low market access and low population density, although there are also significant areas of production in moisture reliable highlands and lowlands, especially in areas of lower population density (Table 11). A fairly large percentage of oilseeds produced are marketed in all domains, although there is substantial variation across domains. Commercialization of oilseeds is greatest in the pastoralist and drought prone lowlands, and is generally greater in less densely populated domains. The effects of market access on oilseed production and commercialization are less clear, as there is significant production and commercialization both in some high and low access areas.

As expected, production and commercialization of vegetables is greatest in high market access areas across all agro-ecological zones, especially in areas of medium population density (except in the pastoral lowlands, where commercialization is greatest in the high access, low density domain). The area under vegetables is small (less than 3%) in all domains. Significant production of vegetables in drought prone and pastoral areas is unlikely without irrigation, so the areas having significant production are probably irrigated.

Commercialization of root crops such as sweet potatoes and potatoes is generally higher in drought prone and pastoral areas than in moisture reliable areas, and is generally higher in areas of higher population density, especially in drought prone areas. The labor intensity and high land productivity of root crop production likely account for the association of commercialization of these crops with higher population density. The association of these crops with drier areas is unexpected, but is likely associated with irrigated areas in some drought prone and most pastoral areas.

Notably, commercialization rates are rather high across the board in pastoralist areas. There are relatively few households engaged in sedentary agricultural activities here, however, and as with the other EASE data for pastoralist areas, this should be read as reflective of non-transitory populations only. Still, it is striking the high rates of market engagement in these areas, even in low-access domains. As mentioned above, these rates may be reflective only of irrigated agriculture in these areas.

Production of coffee is most common in the moisture reliable highlands, although the highest shares of coffee area are found in a few domains considered as drought prone highlands (i.e., drought prone highlands with low access and medium population density or with high access and high population density) and moisture reliable lowlands with low access and low population density. Production of chat is also significant in many drought prone and pastoralist areas, according to the EASE data. These findings of significant coffee and chat production in drought prone and pastoral areas (especially those with low access and low population density) is somewhat surprising.

Livestock ownership varies clearly across the domains, as summarized in Table 12. For cattle, sheep and goats, average household herd sizes are larger for lower access and lower density domains, as well as in areas with less rainfall. These results are consistent with the theory of comparative advantage and location theory, since raising livestock is generally a more extensive and lower value land use than crop production, can be economic in lower rainfall areas, the costs of transporting livestock relative to their value are low, and because larger herd sizes per household can be supported in less densely populated areas due to more available forage. In non-pastoral domains, cattle and sheep herds tend to be larger in highland areas, with the exception of cattle in drought prone domains (where larger lowland herd sizes likely reflect a lower prevalence of tsetse than in moisture reliable lowlands, where herd sizes are smaller). Goats are more prevalent in all lowland areas.

The distribution of employment in agricultural vs. non-agricultural activities is shown by domain in Table 13. Exclusive dependence upon agriculture is higher in the drought prone highlands than elsewhere. In non-pastoral areas, part time agriculture is more common in moisture reliable areas than in drought prone areas, but also more common in lowlands than in highlands. That the highest part-time agriculture rates are found in moisture reliable highland areas is probably a result of greater non-farm opportunities linked to agriculture (such as trading and processing). In pastoral areas, part time or complete dependence on non-agricultural activities (such as trading of salt) may be necessary for household survival in many cases. Non-agricultural employment is most important in areas of medium to high population density or high market access, as expected.

Table 10. Smallholder Commercialization Rates, by Domain

Domain		Average Percent of Production Sold									
		Cereals		Pulses		Oilseeds		Vegetables		Roots	
	# *woredas*	*mean*	*std.dev.*	*mean*	*std.dev.*	*mean*	*std.dev.*	*mean*	*std.dev.*	*mean*	*std.dev.*
Moisture reliable, highland, high access, high density	99	16.7	8.3	18.0	8.9	39.2	22.2	25.2	17.2	26.4	21.5
Moisture reliable, highland, high access, medium density	39	15.9	7.8	20.2	10.8	51.4	23.5	21.5	12.7	19.5	13.3
Moisture reliable, highland, high access, low density	1	13.7	0.0	8.3	0.0			10.0	0.0	0.0	0.0
Moisture reliable, highland, low access, high density	38	16.6	6.4	21.9	6.9	36.5	16.4	22.4	12.5	27.4	18.2
Moisture reliable, highland, low access, medium density	117	16.8	6.6	21.5	8.3	53.2	22.5	22.1	17.1	23.7	16.9
Moisture reliable, highland, low access, low density	9	15.1	8.2	20.9	9.2	42.4	24.5	20.8	8.0	22.0	7.2
Moisture reliable, lowland, high access, medium density	3	9.8	2.3	12.1	2.1	37.2	5.0	32.4	6.8	19.4	7.7
Moisture reliable, lowland, low access, high density	1	21.8	0.0	11.7	0.0	15.7	0.0	12.7	0.0	7.8	0.0
Moisture reliable, lowland, low access, medium density	19	17.9	8.6	19.2	8.4	32.2	19.1	17.4	12.3	17.0	13.2
Moisture reliable, lowland, low access, low density	35	14.5	7.2	14.8	10.9	46.2	23.0	18.3	11.1	15.7	10.7
Drought prone, highland, high access, high density	12	16.6	9.1	19.1	13.1	33.1	22.3	21.0	17.0	33.2	19.9
Drought prone, highland, high access, medium density	15	15.1	8.1	23.4	17.8	34.4	23.9	32.1	24.9	48.2	21.9
Drought prone, highland, high access, low density	1										
Drought prone, highland, low access, high density	7	12.0	5.1	21.9	11.4	38.9	7.2	15.9	9.1	51.7	16.6
Drought prone, highland, low access, medium density	54	12.2	7.5	16.7	7.5	28.4	19.5	21.9	21.0	29.6	20.8
Drought prone, highland, low access, low density	2	4.5	1.0	8.0	0.4	10.6	3.1	0.0	0.0	0.0	0.0
Drought prone, lowland, high access, medium density	4	17.6	10.8	48.0	17.1	34.8	28.2	31.0	36.6	45.2	31.2
Drought prone, lowland, high access, low density	1	18.7	0.0	21.5	0.0			0.0	0.0	0.0	0.0
Drought prone, lowland, low access, medium density	14	13.7	4.9	12.9	6.9	43.8	19.2	10.2	5.1	23.8	21.6
Drought prone, lowland, low access, low density	44	14.5	7.5	13.1	7.5	57.3	19.2	22.3	19.0	25.8	23.9
Pastoralist, high access, high density	1										
Pastoralist, high access, medium density	4	21.5	7.5	28.6	15.9	30.0	8.5	31.6	17.6	29.8	22.2
Pastoralist, high access, low density	3	5.6	3.9	11.2	0.0	60.0	2.5	49.3	15.6	43.8	31.7
Pastoralist, low access, medium density	3	25.2	8.3	16.3	0.0	46.8	0.0	30.0	30.0	30.0	30.0
Pastoralist, low access, low density	55	9.3	6.3	12.2	9.1	68.2	17.8	23.5	34.2	19.4	34.3
National	*581*	*15.5*	*7.7*	*19.2*	*10.2*	*43.4*	*23.4*	*22.3*	*17.9*	*25.4*	*20.4*

Note: *orange values are above 80th percentile of woreda values; yellow values are above 70th percentile; light yellow values are above 60%.*

Source: *2001/2 EASE*

Table 11. Cash Crop Area, by Domain

Domain		Average Percent of Farm Area							
		Coffee		Chat		Oilseeds		Vegetables	
	# woredas	*mean*	*std.dev.*	*mean*	*std.dev.*	*mean*	*std.dev.*	*mean*	*std.dev.*
Moisture reliable, highland, high access, high density	99	11.3	13.9	6.7	7.0	2.1	3.2	2.1	2.9
Moisture reliable, highland, high access, medium density	39	12.8	8.3	1.4	0.7	5.2	4.4	1.2	1.1
Moisture reliable, highland, high access, low density	1							2.2	0.0
Moisture reliable, highland, low access, high density	38	3.4	3.4	8.9	7.9	2.4	3.9	0.7	0.4
Moisture reliable, highland, low access, medium density	117	6.7	8.6	1.8	1.2	6.5	6.5	0.8	0.9
Moisture reliable, highland, low access, low density	9	10.2	4.2			3.8	4.2	0.5	0.5
Moisture reliable, lowland, high access, medium density	3	4.0	2.9	1.0	0.0	0.1	0.0	2.7	2.7
Moisture reliable, lowland, low access, high density	1	5.0	0.0					0.3	0.0
Moisture reliable, lowland, low access, medium density	19	8.1	12.6	1.5	0.5	2.5	6.3	0.8	1.0
Moisture reliable, lowland, low access, low density	35	13.4	14.2	1.6	0.8	6.6	7.2	0.6	0.7
Drought prone, highland, high access, high density	12	17.6	17.5	10.3	7.9	4.0	6.8	0.5	0.6
Drought prone, highland, high access, medium density	15	1.0	0.0	1.0	0.0	2.0	1.7	0.2	0.2
Drought prone, highland, high access, low density	1								
Drought prone, highland, low access, high density	7	6.0	5.7	7.5	2.9	0.9	0.9	0.1	0.0
Drought prone, highland, low access, medium density	54	12.8	12.3	7.2	6.4	2.4	2.6	0.4	0.6
Drought prone, highland, low access, low density	2					0.6	0.3		
Drought prone, lowland, high access, medium density	4			3.0	0.0	8.3	7.7	1.2	1.4
Drought prone, lowland, high access, low density	1								
Drought prone, lowland, low access, medium density	14	1.0	0.0	5.3	6.1	5.5	3.6	0.3	0.2
Drought prone, lowland, low access, low density	44	4.5	5.3	4.9	2.4	13.1	12.3	0.5	0.3
Pastoralist, high access, high density	1	1.0	0.0	9.0	0.0	0.1	0.0	0.4	0.0
Pastoralist, high access, medium density	4			8.0	5.0	0.8	0.5	0.2	0.0
Pastoralist, high access, low density	3	1.0	0.0			2.7	2.0	2.2	2.3
Pastoralist, low access, medium density	3			5.0	0.0	0.2	0.1		
Pastoralist, low access, low density	55			12.5	4.5	11.8	22.3	0.6	0.5
National	*581*	*8.7*	*11.0*	*5.3*	*6.1*	*4.8*	*6.9*	*0.9*	*1.5*

Note: *orange values are above 80th percentile of woreda values; yellow values are above 70th percentile; light yellow values are above 60%.*
Source: *2001/2 EASE*

Table 12. Average Smallholder Herd Size, by Domain

Domain		Average Herd Size					
		Cattle		Sheep		Goats	
	# woredas	*mean*	*std.dev.*	*mean*	*std.dev.*	*mean*	*std.dev.*
Moisture reliable, highland, high access, high density	99	3.0	1.1	0.9	0.8	0.5	0.4
Moisture reliable, highland, high access, medium density	39	4.1	1.1	1.1	1.0	0.5	0.4
Moisture reliable, highland, high access, low density	1	6.3	0.0	1.5	0.0	5.5	0.0
Moisture reliable, highland, low access, high density	38	2.9	0.5	1.0	0.6	0.8	0.5
Moisture reliable, highland, low access, medium density	117	4.0	1.1	1.4	1.1	0.8	0.5
Moisture reliable, highland, low access, low density	9	4.8	1.6	1.0	0.7	1.1	0.8
Moisture reliable, lowland, high access, medium density	3	2.2	0.2	0.4	0.3	0.9	0.6
Moisture reliable, lowland, low access, high density	1	2.3	0.0	0.2	0.0	0.5	0.0
Moisture reliable, lowland, low access, medium density	19	3.1	0.9	1.0	0.8	1.1	1.0
Moisture reliable, lowland, low access, low density	35	3.4	2.7	0.8	1.1	2.2	2.7
Drought prone, highland, high access, high density	12	2.5	0.8	0.7	0.4	1.2	0.8
Drought prone, highland, high access, medium density	15	3.6	1.0	1.7	1.4	1.5	0.8
Drought prone, highland, high access, low density	1						
Drought prone, highland, low access, high density	7	3.2	0.8	1.2	1.9	1.4	0.9
Drought prone, highland, low access, medium density	54	3.1	0.9	1.8	1.7	1.4	0.9
Drought prone, highland, low access, low density	2	6.9	3.9	1.9	0.0	10.7	7.2
Drought prone, lowland, high access, medium density	4	4.8	2.1	1.7	2.2	2.8	2.7
Drought prone, lowland, high access, low density	1	7.1	0.0	0.4	0.0	4.1	0.0
Drought prone, lowland, low access, medium density	14	4.8	1.7	0.6	0.6	3.9	2.9
Drought prone, lowland, low access, low density	44	4.4	3.2	0.8	1.3	2.9	2.9
Pastoralist, high access, high density	1	3.0	0.0	1.9	0.0	5.0	0.0
Pastoralist, high access, medium density	4	4.3	0.7	0.7	0.3	2.0	0.4
Pastoralist, high access, low density	3	12.2	7.7	4.7	3.7	11.7	8.1
Pastoralist, low access, medium density	3	8.3	3.4	4.2	1.4	4.1	0.3
Pastoralist, low access, low density	55	13.6	20.1	10.5	15.4	13.1	13.8
National	*581*	3.9	3.9	1.4	3.0	1.6	3.4

Note: *orange values are above 80th percentile of woreda values; yellow values are above 70th percentile; light yellow values are above 60%.*
Source: *2001/2 EASE*

Table 13. Employment Rates, by Domain

Domain		Average Percentage of Workforce Engaged Primarily in					
		full-time ag.		part-time ag.		non-agriculture	
	# woredas	*mean*	*std.dev.*	*mean*	*std.dev.*	*mean*	*std.dev.*
Moisture reliable, highland, high access, high density	99	76.2	16.4	17.6	11.8	6.2	7.2
Moisture reliable, highland, high access, medium density	39	78.2	13.0	19.4	12.4	2.4	1.4
Moisture reliable, highland, high access, low density	1	85.9	0.0	13.3	0.0	0.8	0.0
Moisture reliable, highland, low access, high density	38	81.1	12.9	16.3	11.9	2.6	2.6
Moisture reliable, highland, low access, medium density	117	78.9	13.7	18.9	12.8	2.2	2.3
Moisture reliable, highland, low access, low density	9	79.6	13.4	18.1	12.1	2.3	1.7
Moisture reliable, lowland, high access, medium density	3	60.7	7.0	31.9	5.7	7.3	2.6
Moisture reliable, lowland, low access, high density	1	50.5	0.0	38.9	0.0	10.6	0.0
Moisture reliable, lowland, low access, medium density	19	77.3	11.1	18.4	9.4	4.3	2.8
Moisture reliable, lowland, low access, low density	35	72.6	17.3	25.0	16.2	2.5	2.6
Drought prone, highland, high access, high density	12	79.1	12.6	17.2	11.5	3.7	3.4
Drought prone, highland, high access, medium density	15	88.1	8.1	9.8	6.4	2.1	2.0
Drought prone, highland, high access, low density	1						
Drought prone, highland, low access, high density	7	72.6	16.5	25.5	15.6	1.9	1.4
Drought prone, highland, low access, medium density	54	85.6	14.0	13.3	13.8	1.1	0.9
Drought prone, highland, low access, low density	2	79.5	12.8	19.3	13.5	1.4	0.8
Drought prone, lowland, high access, medium density	4	82.8	3.3	14.4	2.6	2.9	1.6
Drought prone, lowland, high access, low density	1	69.6	0.0	29.4	0.0	1.0	0.0
Drought prone, lowland, low access, medium density	14	85.8	8.1	12.4	8.1	1.8	1.6
Drought prone, lowland, low access, low density	44	73.7	16.8	24.3	16.0	2.0	2.1
Pastoralist, high access, high density	1	71.8	0.0	20.4	0.0	7.8	0.0
Pastoralist, high access, medium density	4	81.5	7.5	15.4	5.9	3.2	2.0
Pastoralist, high access, low density	3	73.0	13.5	19.1	8.8	7.9	5.2
Pastoralist, low access, medium density	3	83.2	0.8	11.0	3.5	5.9	4.3
Pastoralist, low access, low density	55	80.5	9.3	15.6	7.7	3.9	3.1
National	*581*	*78.8*	*14.6*	*18.2*	*13.1*	*3.0*	*3.8*

***Note**: orange values are above 80th percentile of woreda values; yellow values are above 70th percentile; light yellow values are above 60%.*
***Source**: 2001/2 EASE*

Crop Area and Yields

Tables 14a and 14b show the distribution of crop area for major crop groups, by domain and domain dimension[12]. Note that while most crop production is concentrated in the moisture reliable highlands, some other areas have notably high shares, particularly the low-access/ medium-density areas of the drought prone highlands.

Crop production is concentrated in a few domains: more than 65% of the crop area of cereals, pulses, oilseeds, vegetables and root crops (more than 3/4 of the latter two) is found in the high- and medium-density areas (both low and high access) of the moisture reliable highlands. The four domains that make up this area together only account for 22% of all land area in the country, although they do account for more than 60% of the population.

Another interesting observation is how much production takes place in low-access areas: more than half of the production area for all major crop groups is found in these areas (68% or more for cereals, pulses and oilseeds). A surprising amount of this cropland is also found in low-density areas (although most cropland is in medium-density areas). Vegetables and root crops are, not surprisingly, relatively more prevalent in areas of high access and high population density.

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[12] Please note that the agricultural production data shown here were also taken from the EASE and are based on only one year (2001/2). Although that was a pretty representative year for most parts of the country, production figures are probably more inherently unstable over time than other data used in this analysis. Therefore, these figures should be viewed with the caveat that we do not know exactly how representative they are of woreda production over longer periods of time. It may be interesting to see how well the results presented here are replicated with production averages for multiple years available at a higher level of spatial aggregation (i.e. zonal level).

Table 14a. Crop Area, by Domain

Domain	Area				
	Cereals	Pulses	Oilseeds	Vegetables	Rootcrop
Moisture reliable, highland, high access, high density	**13%**	**13%**	7%	**37%**	**33%**
Moisture reliable, highland, high access, medium density	**10%**	9%	**11%**	10%	6%
Moisture reliable, highland, high access, low density	0%	0%	0%	0%	0%
Moisture reliable, highland, low access, high density	**10%**	**10%**	6%	8%	**15%**
Moisture reliable, highland, low access, medium density	**30%**	**32%**	**45%**	**26%**	**21%**
Moisture reliable, highland, low access, low density	2%	3%	2%	1%	0%
Moisture reliable, lowland, high access, medium density	0%	0%	0%	2%	1%
Moisture reliable, lowland, low access, high density	0%	0%	0%	0%	3%
Moisture reliable, lowland, low access, medium density	2%	3%	2%	3%	7%
Moisture reliable, lowland, low access, low density	2%	2%	5%	3%	2%
Drought prone, highland, high access, high density	2%	2%	1%	1%	2%
Drought prone, highland, high access, medium density	5%	5%	2%	1%	1%
Drought prone, highland, high access, low density	0%	0%	0%	0%	0%
Drought prone, highland, low access, high density	1%	1%	0%	0%	1%
Drought prone, highland, low access, medium density	**14%**	**18%**	7%	5%	3%
Drought prone, highland, low access, low density	0%	0%	0%	0%	0%
Drought prone, lowland, high access, medium density	1%	1%	1%	1%	0%
Drought prone, lowland, high access, low density	0%	0%	0%	0%	0%
Drought prone, lowland, low access, medium density	2%	1%	2%	1%	1%
Drought prone, lowland, low access, low density	3%	1%	7%	1%	1%
Pastoralist, high access, high density	0%	0%	0%	0%	0%
Pastoralist, high access, medium density	2%	0%	0%	0%	1%
Pastoralist, high access, low density	0%	0%	0%	0%	0%
Pastoralist, low access, medium density	0%	0%	0%	0%	0%
Pastoralist, low access, low density	1%	0%	3%	0%	0%
	100%	*100%*	*100%*	*100%*	*100%*

***Note**: Domain shares greater than 10% are shown in bold. Source: 2001/2 EASE*

Table 14b. Crop Area, by Domain Factor

Domain Factor	# woredas	% area	Area				
			Cereals	Pulses	Oilseeds	Vegetables	Rootcrops
Moisture reliable highlands	303	25%	65%	66%	71%	83%	76%
Moisture reliable lowlands	58	12%	5%	5%	7%	8%	13%
Drought prone highlands	91	9%	21%	26%	10%	7%	8%
Drought prone lowlands	63	20%	6%	2%	10%	3%	1%
Pastoralist	66	34%	3%	1%	3%	1%	1%
High access	183	12%	32%	30%	20%	51%	45%
Low access	398	88%	68%	70%	80%	49%	55%
High population density	158	8%	26%	25%	14%	46%	55%
Medium population density	272	31%	66%	68%	69%	48%	42%
Lw population density	151	61%	8%	6%	17%	6%	4%
National	*581*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*

***Source**: 2001/2 EASE*

Yield patterns across domains are show some interesting patterns (Tables 15a and 15b). Cereal yields are, surprisingly, only slightly higher in moisture reliable highlands than drought prone highlands. Even more surprising is that they are highest on average in the moisture reliable lowlands. This may be reflecting other factors, including cultivation histories (e.g. nutrient mined soils in moisture sufficient areas). Pulses have higher yields in the highlands than lowlands, although the highest yields tend to be in the drought prone highlands, rather than the moisture reliable highlands, as expected.

Oilseed yields are fairly flat across agro-ecologies but, as with pulses, are slightly higher in the drought prone highlands. Vegetable and root crop yields are relatively high throughout the moisture reliable domains (both highlands and lowlands) as well as in the drought prone highlands.

Yields tend to be higher in high access and high density areas (except for oilseeds), although not strongly or uniformly so. In general, the positive impacts of market access and population density on yields likely reflects the effects of greater availability of inputs and labor in these areas, and higher returns to using inputs and labor in areas of better access. Oilseeds, by contrast, have highest yields in low access and medium density areas, probably reflecting the facts that oilseeds are readily transportable over large distances, do not require many inputs and are not very labor intensive. The fact that both cereal and pulse yields differ so little between high and low access areas, suggesting that factors other than market access are constraining the use of inputs such as fertilizer.

Cereals, pulses, oilseeds and rootcrops all exhibit their highest yields in medium density domains. Although by no means conclusive, these patterns are consistent with the previously mentioned idea of a U-shaped productivity response to population density, where initial increases encourage more efficient production, but eventually pass a threshold where population density represents excessive demands on the resource base (Scherr and Hazell 1994; Pender 1998).

Table 15a. Average Yields, by Domain

Domain	Yield				
	Cereals	Pulses	Oilseeds	Vegetables	Rootcrops
Moisture reliable, highland, high access, high density	9.74	7.62	2.50	51.77	71.13
Moisture reliable, highland, high access, medium density	14.88	9.30	4.12	56.24	102.71
Moisture reliable, highland, high access, low density	0.57	1.21		147.04	87.05
Moisture reliable, highland, low access, high density	14.54	11.05	4.16	59.44	107.60
Moisture reliable, highland, low access, medium density	14.07	10.19	4.25	51.81	103.64
Moisture reliable, highland, low access, low density	11.61	7.73	2.14	61.77	93.10
Moisture reliable, lowland, high access, medium density	15.93	7.28	1.84	47.73	99.03
Moisture reliable, lowland, low access, high density	8.69	7.12	1.75	93.33	94.47
Moisture reliable, lowland, low access, medium density	11.80	8.17	3.28	72.97	95.36
Moisture reliable, lowland, low access, low density	13.49	6.72	3.40	51.40	77.66
Drought prone, highland, high access, high density	11.03	8.47	2.83	65.58	92.30
Drought prone, highland, high access, medium density	12.49	10.60	4.47	65.33	129.39
Drought prone, highland, high access, low density					
Drought prone, highland, low access, high density	13.70	10.52	6.16	39.69	98.06
Drought prone, highland, low access, medium density	12.31	10.89	4.12	51.96	114.65
Drought prone, highland, low access, low density	10.37	8.33	3.93		
Drought prone, lowland, high access, medium density	10.97	6.75	3.81	65.06	119.29
Drought prone, lowland, high access, low density	5.04	3.66	1.00		116.33
Drought prone, lowland, low access, medium density	6.81	4.31	2.74	17.86	45.59
Drought prone, lowland, low access, low density	8.96	5.10	3.86	27.05	54.00
Pastoralist, high access, high density	13.87	10.58	2.70	146.60	106.26
Pastoralist, high access, medium density	16.59	8.03	4.11	83.69	113.17
Pastoralist, high access, low density	12.63	0.62	3.64	133.12	89.47
Pastoralist, low access, medium density	6.85	0.80	0.59	73.00	31.33
Pastoralist, low access, low density	1.70	0.64	0.61	10.48	11.40
National Average	11.14	7.84	3.33	48.18	82.95

Note: *Domain values greater than national woreda-level average shown in bold. Source: 2001/2 EASE*

Table 15b. Average Yields, by Domain Factor

Domain Factor	# woredas	% area	Yield				
			Cereals	Pulses	Oilseeds	Vegetables	Rootcrops
Moisture reliable highlands	303	25%	12.7	9.2	3.6	53.9	93.0
Moisture reliable lowlands	58	12%	13.0	7.2	3.3	59.0	84.9
Drought prone lowlands	91	9%	12.1	10.3	4.1	53.3	109.1
Drought prone lowlands	63	20%	8.5	5.0	3.6	27.0	57.3
Pastoralist	66	34%	3.5	1.2	1.0	25.4	23.5
High access	183	12%	11.4	8.1	3.1	57.5	86.9
Low access	398	88%	11.0	7.7	3.5	43.9	81.1
High population density	158	8%	11.2	8.7	3.1	55.0	83.1
Medium population density	272	31%	13.1	9.6	4.0	53.8	103.1
Low population density	151	61%	7.5	3.9	2.4	30.9	46.6
National	581	100%	11.1	7.8	3.3	48.2	82.9

Source: *2001/2 EASE*

Chronic Food Insecurity

Tables 16a and 16b show the number of years in the past 12 that significant emergency food aid need assessments have been made for the woredas in the domain. These need assessments are perhaps the most direct available measure of food insecurity at the woreda level. The average number of years of neediness provides some indication of chronic insecurity. The average frequency of need is much higher in drought prone highland woredas than elsewhere and somewhat higher in low access than in high access areas, and higher in medium and high population density woredas than in low density woredas. Although the woredas in most domains show a wide range of frequency of food aid needs, where chronic neediness is pronounced within a given domain or set of domains (e.g. in low access areas in the drought prone highlands), this should be factored into strategies aimed at those areas.

In summary, most, but certainly not all, of the patterns of livelihood strategies, crop production and food insecurity are consistent with our expectations, and strengthen our conviction that these domains are useful in reflecting differences in agricultural development potentials and constraints across the diverse circumstances of Ethiopia. The domains do a better job at capturing some dimensions of rural smallholder livelihood strategies and outcomes than others. Some of the unexpected results likely result from other factors operating at a more local level (such as differences in access to information and services, community organizations and institutions, and household endowments), and may indicate development opportunities. For example, evidence of low yields or low engagement in high-value production within areas of high market access and population density may indicate areas to strengthen existing extension services, or to investigate other possible reasons for underperformance and underengagement. Certainly, new research questions and data collection activities may be suggested by looking further at the patterns shown here.

Table 16a. Frequency of Annual Emergency Food Aid Need, by Domain, 1994-2005

Domain	# woredas	Minimum	Maximum	Average
Moisture reliable, highland, high access, high density	99	0	12	3.0
Moisture reliable, highland, high access, medium density	39	0	11	1.9
Moisture reliable, highland, high access, low density	1	10	10	10.0
Moisture reliable, highland, low access, high density	38	0	12	5.1
Moisture reliable, highland, low access, medium density	117	0	11	3.2
Moisture reliable, highland, low access, low density	9	0	10	2.0
Moisture reliable, lowland, high access, medium density	3	0	10	5.7
Moisture reliable, lowland, low access, high density	1	10	10	10.0
Moisture reliable, lowland, low access, medium density	19	0	11	3.8
Moisture reliable, lowland, low access, low density	35	0	10	3.1
Drought prone, highland, high access, high density	12	0	12	6.3
Drought prone, highland, high access, medium density	15	0	12	7.1
Drought prone, highland, high access, low density	1	0	0	0.0
Drought prone, highland, low access, high density	7	0	12	7.1
Drought prone, highland, low access, medium density	54	0	12	9.1
Drought prone, highland, low access, low density	2	8	11	9.5
Drought prone, lowland, high access, medium density	4	1	8	4.3
Drought prone, lowland, high access, low density	1	10	10	10.0
Drought prone, lowland, low access, medium density	14	0	12	4.9
Drought prone, lowland, low access, low density	44	0	12	3.3
Pastoralist, high access, high density	1	0	0	0.0
Pastoralist, high access, medium density	4	7	12	9.5
Pastoralist, high access, low density	3	5	10	7.0
Pastoralist, low access, medium density	3	0	7	4.3
Pastoralist, low access, low density	55	0	9	1.3
National	*581*	*0*	*12*	*4.0*

***Note**: Assessments made at woreda level. Source: DPPC*

Table 16b. Frequency of Annual Emergency Food Aid Need, by Domain Factor, 1994-2005

Domain Factor	# woredas	Average
Moisture reliable highlands	303	3.2
Moisture reliable lowlands	58	3.6
Drought prone highlands	91	8.2
Drought prone lowlands	63	3.8
Pastoralist	66	2.2
High access	183	3.7
Low access	398	4.1
High population density	158	4.0
Medium population density	272	4.7
Low population density	151	2.7
National	581	4.8

***Note**: Assessments made at woreda level. Source: DPPC*

V. DISCUSSION: EMERGING POLICY IMPLICATIONS

An initial observation from the data compiled here is that people are pursuing a wide diversity of livelihoods across the range of geographical conditions addressed by these development domains. Part of the heterogeneity of livelihoods pursued within domains surely reflects "non-geographical" variation in household level and other characteristics. Some of it certainly also reflects geographical characteristics that are not well captured at the woreda level of observation: recall that while capturing much important variation in conditions, many woredas contain quite varied biophysical, infrastructural and demographic conditions within their boundaries as well.

Nonetheless, from the foregoing discussion, it is clear that some important aspects of smallholder livelihood patterns are being captured by development domains as defined here. But development domains should be more than tabulations of livelihood traits in order to be of strategic value for policymakers. How do the domain characteristics described above help to provide a framework for understanding strategic development options?

In order to begin to derive potential policy implications, we may start by looking at the major development objectives laid out in the PASDEP (MoFED 2005). An overarching goal for Ethiopia is the transformation of smallholder agriculture from subsistence to market orientation. Another major goal is increased productivity, through labor intensive strategies where possible, and where appropriate to local conditions.

Increased Commercialization

Currently most of the crop production in the country comes from the moisture reliable highlands (Table 17). However, if we look at the share of market engagement (Table 10) we see a more even distribution of commercialization rates across domains. As mentioned above, the share of household production of cereals and pulses sold in the drought prone areas appears more constrained by market access than the shares in moisture reliable domains. This may indicate that physical access constraints are more critical for commercialization of food crop production in drought prone than moisture reliable areas, perhaps because household vulnerability to risks in these areas is exacerbated by lack of market access (i.e., farmers who are vulnerable to risks may be very reluctant to engage in commercial production where markets are not well developed due to poor access). Infrastructure investments in drought prone areas, therefore, may help to overcome a critical constraint to commercialization for a large number of people (note that 12% of the population lives in one domain alone: low-access, medium-density areas of the drought prone highlands).

In moisture reliable areas, market access appears more important for enabling production and commercialization of higher value vegetables and root crops, than for promoting commercialization of staples such as cereals and pulses. Thus, infrastructure investments in these environments can also promote commercialization, but likely of different commodities. Other investments and policies that help to support development of such high value commodities are more likely to be important in the agricultural development strategy pursued in these higher potential environments.

Targeting of infrastructure investment should not necessarily prioritize the densest population centers to promote commercialization. The relationship between market access and commercialization in the drought prone areas appears strongest for medium-density, rather than high-density areas. This is probably because the potential for surplus commercial production of food crops is limited in high population density, drought prone areas, as a result of small farm sizes, low crop productivity, and in many cases, severe land degradation. In densely populated drought prone areas, communities may have more limited abilities to take advantage of increases in access to pursue an expanded set of livelihood decisions involving specialization and intensification of production. However, this does not mean that such areas should be neglected, since poverty and food insecurity tend to be very severe in these areas. But investments in human capital, such as formal education and vocational training, as well as policies to facilitate migration to areas of higher economic potential and less environmental stress (such as changing land tenure policies that cause households to lose their land rights if they migrate out of the community) may offer better prospects for improving households' livelihoods in this domain.

There are other strong entry points for market development as well. Efforts to improve communication infrastructure, market information systems, cooperatives and other institutions, are perhaps better targeted at areas with better physical infrastructure already in place, and with some existing market oriented production. The potential for promoting increased production and commercialization of high value commodities such as vegetables, fruits, and dairy products, though such infrastructural and institutional development, is likely to be greatest in high-access, high-density areas of the moisture reliable highlands, and could potentially benefit more than 20% of the Ethiopian rural population that lives in these areas. Because of higher population densities and greater market engagement rates in this domain, spillover benefits resulting from investments may be very high in these areas. Lower levels of chronic food insecurity in these areas may mean that household gains are less likely to be lost again to welfare shocks. Since the measure most indicative of smallholder commercial behavior was access to local markets, this may imply a strategy to focus efforts in smaller regional markets, rather than on building up major corridors.

In lowland areas with poorer market access and low population density, production and commercialization of oilseeds and livestock products appears to hold major promise, given the higher level of production of these commodities already observed in these areas. Strategies to build upon these comparative advantages in this domain could include promoting/attracting investment in processing facilities for oil crops and livestock products, increased emphasis on improving oilseed and livestock productivity in agricultural research and extension programs, investments in livestock vaccination and health facilities, livestock credit, and others.

Table 17. Share of National Production, by Domain

Domain	Share of National Production, 2001-2				
	Cereals	Pulses	Oilseeds	Vegetables	Rootcrop
Moisture reliable, highland, high access, high density	**15%**	**14%**	4%	**44%**	**35%**
Moisture reliable, highland, high access, medium density	**12%**	9%	5%	**10%**	6%
Moisture reliable, highland, high access, low density	0%	0%	0%	0%	0%
Moisture reliable, highland, low access, high density	**11%**	**11%**	7%	8%	**14%**
Moisture reliable, highland, low access, medium density	**33%**	**32%**	**44%**	**19%**	**17%**
Moisture reliable, highland, low access, low density	1%	2%	1%	1%	0%
Moisture reliable, lowland, high access, medium density	0%	0%	0%	1%	1%
Moisture reliable, lowland, low access, high density	0%	0%	0%	0%	1%
Moisture reliable, lowland, low access, medium density	2%	2%	1%	3%	3%
Moisture reliable, lowland, low access, low density	2%	2%	6%	2%	1%
Drought prone, highland, high access, high density	2%	3%	1%	1%	3%
Drought prone, highland, high access, medium density	4%	6%	0%	2%	5%
Drought prone, highland, high access, low density	0%	0%	0%	0%	0%
Drought prone, highland, low access, high density	1%	1%	0%	0%	3%
Drought prone, highland, low access, medium density	**11%**	**16%**	4%	4%	6%
Drought prone, highland, low access, low density	0%	0%	0%	0%	0%
Drought prone, lowland, high access, medium density	1%	2%	1%	4%	0%
Drought prone, lowland, high access, low density	0%	0%	0%	0%	0%
Drought prone, lowland, low access, medium density	1%	0%	1%	0%	1%
Drought prone, lowland, low access, low density	2%	0%	**15%**	1%	1%
Pastoralist, high access, high density	0%	0%	0%	0%	0%
Pastoralist, high access, medium density	2%	1%	0%	0%	1%
Pastoralist, high access, low density	0%	0%	0%	1%	1%
Pastoralist, low access, medium density	0%	0%	0%	0%	0%
Pastoralist, low access, low density	0%	0%	**10%**	1%	0%
National averag	100%	100%	100%	100%	100%

***Note**: Values in bold are 10% or more of national total. Source: 2001/2 EASE*

Increased Productivity

Increasing agricultural productivity, especially of staple food crops, is a recurring strategic theme in Ethiopia, not only as a sectoral objective, but also as a central food security goal (e.g. MoFED 2002, 2005). Given the fact that the bulk of staples production comes from moisture reliable highland areas, yield increases in these areas would create the most surplus. Additionally, productivity constraints are less in these areas than in drought prone areas.

However, the data on yields assembled for this analysis tell an interesting story. The apparent impact of market access on yields is much different in the lowlands than in the highlands (Table 18). Lowland yields are notably higher in better access domains, while highland yields are often higher in low access domains. This could be telling a historical story in part: high-access areas in the highlands generally have higher population densities and have been cultivated intensively for longer periods of time (certainly when compared with lowland domains, but possibly also when compared with low-access highland areas). It could be that the potential yield impacts of higher access (e.g. through lower input costs, more frequent extension, etc.) have been outweighed by long-term land degradation, or else have not been realized for other reasons (e.g. poorly functioning institutions). Further research and data for more years might clarify this picture somewhat. Nonetheless, it might be that investments in improved market access in the lowlands yield a higher return than comparable investments in the highlands, in terms of promoting improved productivity. By contrast, investments in improved advisory services, credit and farm inputs and sustainable land management in high access areas of the highlands may be needed to reduce the apparent productivity gap in these areas.

Table 18. Yields by Agricultural Potential and Market Access Zones

Agricultural Potential	**Average Yields**					
	Mkt. access	**Cereals**	**Pulses**	**Oilseeds**	**Vegetables**	**Rootcrops**
Moisture reliable, highland	high access	11.1	8.0	2.9	53.7	80.1
	low access	14.0	10.3	4.1	54.1	104.0
Moisture reliable, highland average		12.70	9.24	3.57	53.94	93.03
Moisture reliable, lowland	high access	15.9	7.3	1.8	47.7	99.0
	low access	12.8	7.2	3.3	59.6	84.1
Moisture reliable, lowland average		12.98	7.23	3.25	59.00	84.85
Drought prone, highland	high access	11.4	9.3	3.6	63.1	108.9
	low access	12.4	10.8	4.3	48.9	109.2
Drought prone, highland average		12.10	10.32	4.12	53.30	109.08
Drought prone, lowland	high access	9.8	6.1	3.2	52.0	118.7
	low access	8.4	4.9	3.6	24.8	52.0
Drought prone, lowland average		8.55	5.01	3.56	26.99	57.27
Pastoralist	high access	14.8	5.6	3.8	110.1	103.4
	low access	2.0	0.6	0.6	13.7	12.4
Pastoralist average		3.52	1.25	0.99	25.39	23.46
	National Average	*11.14*	*7.84*	*3.33*	*48.18*	*82.95*

***Source**: 2001/2 EASE*

As a way of meeting not only sectoral goals of enhanced productivity but also for rural employment generation, the PASDEP explicitly seeks to find opportunities for the expansion of labor-intensive productive activities. Labor intensive soil and water conservation schemes might be best targeted to medium and high population density areas of the highlands, focusing on high-access as well as low-access domains. Because of their more immediate impact on productivity in moisture stressed environments, soil and water conservation investments often tend to yield higher returns in drought prone areas than in moisture reliable areas (Pender, et al. 2006b; Pender and Gebremedhin 2004; Herweg 1993), so targeting these investments to such domains is likely to be most promising. In higher rainfall environments, other investments, such as drainage investments (especially in vertisol areas prone to waterlogging), agroforestry and use of cover crops, green manures and mulches are likely to be more promising investments than soil and water conservation structures.

Identifying development priorities

Synthesizing from some of the foregoing observations, we may identify several apparent policy implications. First, development of transportation infrastructure in the *drought prone highlands* is a priority in the medium-density areas for two reasons: yields also tend to be highest in these areas (indicating more marketable surplus) and the association between better access and marketing is strongest in these areas.

Infrastructure development in the *moisture reliable highlands* should prioritize improved communications, market information systems (and be accompanied by development of associated institutions) in medium- and high-density, high-access areas, where high-value production is highest. At the same, yields are relatively low in high-density, high-access areas (suggesting land degradation issues) and strategies for both improved land management and non-farm employment should be considered. In low-access areas of medium-density, yields are relatively high and marketing levels could be brought up through targeted infrastructure investments (similar to equivalent areas in the drought prone highlands).

In the both the *moisture reliable* and *drought prone lowlands*, low productivity is an issue to which this analysis is unable to suggest a clear policy response: although very erratic, productivity tends to be highest in areas of higher density and higher access as well as in areas of low density and low access. This divergence is most pronounced in the drought prone lowlands.

Pastoralist areas have surprisingly good yield and marketing indicators, especially in areas of medium- and high-density and good market access. However, these are relatively few areas, and are likely the result of irrigated production. Opportunities for expanding such systems should be explored. At the same time, emphasis on improving livestock production and marketing systems for pastoralist populations should be maintained.

The fact that marketing levels and yields appear poorly associated warrants further investigation. This may indicate that areas of relatively high commercialization have been overtaxing their production base, perhaps partly in consequence of market-oriented intensification. This and other findings should be investigated further, ideally using household-level analysis to compliment the woreda-level analyses presented here.

Of course, more specific recommendations may be filtered through more detailed consideration of the conditions pertaining in individual domains (including viable crops for specific areas). More detailed strategy options are compiled and presented in Appendix A. Although these options are more detailed than the general observations made here, they should still be considered indicative of the kinds of investment areas most likely to pay off in different domains, rather than a narrowly prescriptive list of recommendations.

VI. CONCLUSIONS

Development domains as presented here capture (if imperfectly) some important geographical factors influencing smallholder livelihood options and rural economic outcomes in Ethiopia. The theoretical importance of agricultural potential, market access and population density has been supported in the work presented here, via empirical evidence of a range of production characteristics assembled at the woreda level. The geographical patterns observed here strongly argue for the inclusion of market access and population density over simple agro-ecological frames for development strategies, such as the Three Ethiopias. Failure to go beyond agroecology toward a broader set of geographical development conditions, such as those presented here, will certainly limit the effectiveness of geographically-informed efforts to guide development strategy.

For example, the PASDEP's linking of the promotion of industrially manufactured fertilizers to moisture reliable areas (based on a logic of higher returns) will likely be most effective in high-access areas of the highland (and may not work at all in low-access and lowland areas). Similarly, targeting water harvesting and small-scale irrigation to drought prone areas makes the most sense in areas with adequate labor and access to markets. Promoting income diversification through non-farm activities (another strategy which is broadly targeted to drought prone areas) will suffer similar constraints, and may obscure the value of such interventions in high-density, high-access moisture reliable areas.

Among the investment priorities suggested by the analysis in the preceding section, we may highlight the results most salient for the current policy dialog, which is focused on raising both productivity and commercialization of smallholders:

- Investments in expanding basic infrastructure (especially road networks) should prioritize productive areas with sufficient labor resources, especially in the highlands where the highest yields are in low access areas (probably reflecting lower degradation levels). These investments should be accompanied by promotion of sustainable land management practices to maintain and increase land productivity. Targeting medium- and high-density areas with poor access in the drought prone and moisture reliable highlands could have significant benefits for the 45% of the national population who live in these areas[13].

- Within medium-density, high access areas throughout the highlands, yields are good (compared with biophysically similar areas) and marketing levels are relatively good. Investments in market information, communication infrastructure, and strengthening marketing institutions could build on these favorable characteristics.
- High-density areas with high-access in the highlands have relatively low productivity for most commodities, despite having relatively high commercialization rates. This is likely attributable to an overtaxed resource base and suggests the targeted promotion of land management technologies as well as off-farm employment in these areas.

While these domains do provide insights into development opportunities that are of relevance to the current policy discussion, it is important to recall some basic limitations of the domains framework. There are certainly many aspects of Ethiopian smallholder behavior that are not well explained by the domains defined here. Some of this may be captured by better data, or be better explained by analysis at a higher level of resolution. On the other hand, some of the smallholder behavior or livelihood outcomes which are unexplained by domain factors (or which are explained in a statistical sense but non-intuitive) may represent actionable policy gaps, i.e. areas in which policy instruments can be better tuned to bring about desired results. For example, in high potential and high market access areas with low levels of commercialization, input use or yields, policy makers may seek to identify and overcome non-geographical constraints to smallholders taking advantage of favorable production and access conditions (which may have to do with, for example, limitations of local institutions or information availability).

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[13] These are the following domains: moisture reliable, highland / low access / high density; moisture reliable, highland / low access / medium density; drought prone, highland / low access / high density; and drought prone, highland / low access / medium density.

We must also bear in mind that domains are not static. For example, as investments in roads, ICT and other infrastructure takes place, the spatial expression of access constraints will change, as will behavioral responses by smallholders. These responses may trigger yet others. Changes in population, land degradation, and climate change are examples of other dynamic forces that can change the nature of the development domains and the opportunities and constraints within each domain. In short, the framework and definitions we have attempted to validate here should be seen as part of an evolving system of conditions and responses, with both spatially and temporally important dimensions. The development decisions that domains can help guide may, in turn, affect the conditions that domains seek to represent.

Nonetheless, the set of domains presented here do help to highlight some strategic directions that are of immediate relevance. Among these are the enormous potential for unlocking rural market engagement by strengthening infrastructure and reducing remoteness in productive labor-surplus areas, reducing other commercialization and productivity constraints in high-access areas, and the continuing importance of promoting and enabling sustainable land management throughout the high density highlands.

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APPENDIX 1

Development Priorities by Development Domain

Table 1a. Agricultural Development Priorities within Ethiopian Development Domains

Agricultural potential	Market access	Priorities	Potential Agricultural Development/Livelihood Options		
			High pop density	Medium pop density	Low pop density
MOISTURE RELIANT HIGHLANDS	HIGH	*Productivity Growth* • broad agricultural inputs • weed & pest control • soil & water management • specialized irrigation (e.g. for hort.) *Market Improvement* • market intelligence (domestic, regional & international) • institutional dev't (e.g., coops) *Linkages with non-agriculture* • storage, processing, distribution • microfinance, coops & rural banks • infrastructure, esp. communication	*Example locations*: Gurage zone, areas near Rift Valley *Options:* Without irrigation investment: intensive livestock: beef, poultry, beekeeping; high input cereals With irrigation investment perishable cash crops ; dairy, intensive livestock Off-farm activities micro and small scale enterprises; employment generation schemes	*Example locations*: West Wellega *Options:* Without irrigation investment: extensive livestock (improved grazing areas, animal health, poultry, beekeeping); high input cereals; woodlots With irrigation investment: perishable cash crops ; dairy, intensive livestock Off-farm activities micro and small scale enterprises; employment generation schemes	*Example locations*: Yabelo, Borena zone *Options:* Without irrigation investment: extensive livestock (improved grazing areas, animal health, poultry, beekeeping); high input cereals; woodlots
	LOW	*Productivity Growth* • broad agricultural inputs • weed and pest control • soil and water management *Market Improvement* • infrastructure, esp. roads	*Example locations:* Hadiya zone, West Gojam *Options:* high input cereals; extensive livestock; intensive poultry, beekeeping; public work schemes	*Example locations:* East Hararge, interior Gonder *Options:* extensive livestock; improved pasture management, improved nutrition, animal health; high input cereals	*Example locations: Shaka & Kafa zones in* SW highlands *Options:* extensive livestock; improved pasture management, improved nutrition, animal health; high input cereals

***Source**: compiled by authors based on Ethiopian national strategy documents (FDRE 2001, MoFED 2002), empirical research in Ethiopia (in particular, Pender, Place and Ehui 1999, Pender 2004, and Ehui and Pender forthcoming), and expert consultations.*

Table 1b. Agricultural Development Priorities within Ethiopian Development Domains

Agricultural potential	Market access	Priorities	Potential Agricultural Development/Livelihood Options		
			High pop density	Medium pop density	Low pop density
DROUGHT PRONE HIGHLANDS	HIGH	*Productivity Growth* • targeted inputs (cash crops) • weed & pest control • soil & water management • irrigation *Market Improvement* • market intelligence (domestic, regional) • institutional dev't (e.g., coops) *Linkages with non-agriculture* • storage, processing, distribution • microfinance, coops & rural banks • infrastructure	*Example locations*: isolated areas in east Showa & near Rift Valley *Options:* Without irrigation investment: intensive livestock: beef, poultry, beekeeping; low input cereals With irrigation investment high input cereals; perishable cash crops ; dairy, intensive livestock Off-farm activities micro and small scale enterprises; employment generation schemes	*Example locations:* isolated areas in east Showa & near Rift Valley *Options:* Without irrigation investment: extensive livestock (improvec grazing areas, animal health, poultry, beekeeping); low input cereals; woodlots With irrigation investment: high input cereals; perishable cash crops ; dairy, intensive livestock Off-farm activities micro and small scale enterprises; employment generation schemes	*Example locations*: Gisum, near Jijiga *Options:* Without irrigation investment: extensive livestock (improvec grazing areas, animal health, poultry, beekeeping); low input cereals; woodlots Off-farm activities micro and small scale enterprises; employment generation schemes
	LOW	*Productivity Growth* • limited inputs • weed and pest control • soil and water management *Market Improvement & linkages* • infrastructure, esp. roads	*Example locations:* isolated areas in northern and eastern highlands *Options:* low input cereals; extensive livestock; resettlement; public work schemes	*Example locations:* most of eastern Tigray and Amhara *Options:* extensive livestock; improved pasture management, improved nutrition, animal health; low input cereals; public work schemes	*Example locations:* Gelana Abaya *Options:* extensive livestock; improved pasture management, improved nutrition, animal health; low input cereals; public work schemes

***Source**: compiled by authors based on Ethiopian national strategy documents (FDRE 2001, MoFED 2002), empirical research in Ethiopia (in particular, Pender, Place and Ehui 1999, Pender 2004, and Ehui and Pender forthcoming), and expert consultations.*

Table 1c. Agricultural Development Priorities within Ethiopian Development Domains

Agricultural potential	Market access	Priorities	Potential Agricultural Development/Livelihood Options		
			High pop density	Medium pop density	Low pop density
MOISTURE RELIANT LOWLANDS	HIGH	*Productivity Growth* • broad agricultural inputs • disease & pest control • soil and water management *Market Improvement* • market intelligence (domestic & regional) *Linkages with non-agriculture* • storage, processing, distribution • microfinance, coop's & rural banks • infrastructure	*Example locations:* none	*Example locations:* isolated areas in south and west *Options:* high input cereals; extensive livestock; resettlement; off-farm activities (micro and small scale enterprises & employment generation schemes)	*Example locations:* none
	LOW	*Productivity Growth* • broad agricultural inputs • weed and pest control • soil and water management *Market Improvement* • infrastructure, esp. roads	*Example locations:* Kindo Koysha, Wolaiyta zone *Options:* high input cereals; extensive livestock; Resettlement; public works schemes	*Example locations:* South Omo, Gamo Gofa, Dawuro *Options:* extensive livestock; improved pasture management, improved nutrition, animal health; high input cereals; public works schemes	*Example locations:* most of the west, much of the south *Options:* extensive livestock; improved pasture management, improved nutrition, animal health; high input cereals; public works schemes

Source*: compiled by authors based on Ethiopian national strategy documents (FDRE 2001, MoFED 2002), empirical research in Ethiopia (in particular, Pender, Place and Ehui 1999, Pender 2004, and Ehui and Pender forthcoming), and expert consultations.*

Table 1d. Agricultural Development Priorities within Ethiopian Development Domains

Agricultural potential	Market access	Priorities	Potential Agricultural Development/Livelihood Options		
			High pop density	Medium pop density	Low pop density
DROUGHT PRONE LOWLANDS	HIGH	*Productivity Growth* • broad agricultural inputs • disease & pest control • soil and water management • irrigation *Market Improvement* • market intelligence (domestic & regional) *Linkages with non-agriculture* • storage, processing, distribution • microfinance, coop's & rural banks • infrastructure	*Example locations:* none	*Example locations:* Jile Tumuga *Options:* extensive livestock; improved pasture management, improved nutrition, animal health; low input cereals; off-farm activities (micro and small scale enterprises & employment generation schemes)	*Example locations:* Liben, Borena zone *Options:* extensive livestock; improved pasture management, improved nutrition, animal health; low input cereals; off-farm activities (micro and small scale enterprises & employment generation schemes)
	LOW	*Productivity Growth* • broad agricultural inputs • weed and pest control • soil and water management *Market Improvement* • infrastructure, esp. roads	*Example locations:* none	*Example locations:* Afar near South Wollo escarpment *Options:* low input cereals; extensive livestock; public works schemes	*Example locations:* parts of Bale, Hararge and other transitional areas in SE *Options:* extensive livestock; improvec pasture management, improved nutrition, animal health; low input cereals; public works schemes

Source*: compiled by authors based on Ethiopian national strategy documents (FDRE 2001, MoFED 2002), empirical research in Ethiopia (in particular, Pender, Place and Ehui 1999, Pender 2004, and Ehui and Pender forthcoming), and expert consultations.*

Table 1e. **Agricultural Development Priorities within Ethiopian Development Domains**

Agricultural potential	Market access	Priorities	Potential Agricultural Development/Livelihood Options		
			High pop density	Medium pop density	Low pop density
PASTORAL LOWLANDS	HIGH	<u>*Productivity Growth*</u> • targeted inputs • animal health • soil and water management • irrigation <u>*Market Improvement*</u> • market intelligence (domestic & regional) <u>*Linkages with non-agriculture*</u> • storage, processing, distribution • microfinance, coop's & rural banks • infrastructure, esp. electrification	*Example locations:* near Dire Dawa *Options:* irrigated horticulture; extensive livestock; off-farm activities (micro and small scale enterprises & employment generation schemes)	*Example locations:* Rift Valley, Jijiga *Options:* irrigated horticulture; extensive livestock; improved pasture management, improved nutrition, animal health; off-farm activities (micro and small scale enterprises & employment generation schemes)	*Example locations:* Moyale *Options:* irrigated horticulture; extensive livestock; improved pasture management, improved nutrition, animal health; off-farm activities (micro and small scale enterprises & employment generation schemes)
	LOW	<u>*Productivity Growth*</u> • targeted agricultural inputs • animal health • soil and water management <u>*Market Improvement*</u> • Infrastructure, esp. roads	*Example locations:* none	*Example locations:* Mieso, Teferi Ber *Options:* extensive livestock; improved pasture management, improved nutrition, animal health; low input cereals; public work schemes	*Example locations:* most of Afar and Somali regions *Options:* extensive livestock; improved pasture management, improved nutrition, animal health; low input cereals; public work schemes

Source*: compiled by authors based on Ethiopian national strategy documents (FDRE 2001, MoFED 2002), empirical research in Ethiopia (in particular, Pender, Place and Ehui 1999, Pender 2004, and Ehui and Pender forthcoming), and expert consultations.*

APPENDIX 2

Notes on Data

This appendix contains notes on data used in the analysis presented.

I. Agricultural Potential

To characterize agroecological conditions, we used data on rainfall, rainfall variability and elevation.

Rainfall data are from the WorldClim datasets produced by Robert Hijmans at the University of California at Berkeley. The inputs to these interpolated datasets are weather station data from the National Meteorological Services Agency. These data and their description are available on-line at http://biogeo.berkeley.edu/worldclim/worldclim.htm

Rainfall variability, indicated by the coefficient of variation of long-term average rainfall, was calculated by the International Food Policy Institute, based on weather station data from the National Meteorological Services Agency covering the period 1965-2000.

Elevation data are from the Shuttle Radar Topography Mission (SRTM) data compiled by the National Geospatial-Intelligence Agency (NGA) and the National Aeronautics and Space Administration (NASA) of the United States. Data and documentation are available on-line at http://www2.jpl.nasa.gov/srtm/index.html

II. Market Access Indicator Variables

A variety of physical market access indicators were evaluated. All were prepared at the woreda level. These can be grouped into three categories: travel time indicators, road density indicators, and interaction model output.

Travel Time Indicators

These indicators use estimated travel times to a set of market locations. Within a geographic information system, travel times are estimated for every location in the country to the nearest market of a given definition, with the assumption that on-road travel takes place by motor vehicle and that off-road travel takes place by non-motorized transport or foot (see Deichmann 1997 and Deichmann and Bigman 2000 for descriptions of models with similar assumptions). On-road transportation times are estimated on the basis of road quality, modified by slope.[14] Off-road transportation times are estimated by land cover, also modified by slope.[15] The model is a cumulative, cost-distance model implemented in a raster analytical environment[16].

The variables used in this study are:

- ★ travel time to nearest town of 2,000 or more inhabitants
- ★ travel time to nearest town of 5,000 or more inhabitants
- ★ travel time to nearest town of 10,000 or more inhabitants
- ★ travel time to nearest town of 20,000 or more inhabitants
- ★ travel time to nearest town of 50,000 or more inhabitants
- ★ travel time to nearest town of 100,000 or more inhabitants
- ★ travel time to Addis Ababa

Road Density Indicators

These indicators use the density of roads to gauge the relative accessibility or remoteness of different areas. They are based on calculating a ratio between total road length for a given type of road in a given area, and a base variable. In this case we only considered total land area as a base variable, although other variables are possible (e.g. length of road per person).

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[14] Data on the quality and location of roads is based on data originating with the Ethiopian Mapping Authority, modified on the basis of field visits by the World Food Program, and further modified by IFPRI in consultation with various secondary data sources and primary data collection. Slope is calculated on the basis of a 90 meter resolution digital elevation model, constructed from data from the Shuttle Radar Topography Mission: SRTM. 2004. SRTM30 dataset. National Geospatial-Intelligence Agency (NGA) and the National Aeronautics and Space Administration (NASA). Information available on-line: http://www2.jpl.nasa.gov/srtm/index.html

[15] Landcover data is from: Global Vegetation Monitoring. 2004. Unit Global Land Cover 2000 Project and datasets (GLC 2000). Available on-line: http://www.gvm.sai.jrc.it/glc2000/defaultGLC2000.htm

[16] For this model, we used the COSTDISTANCE function available under the GRID module of ArcInfo 8.1.

The variables used in this study are:

- road density, all-weather (woreda ratio): this variable is the ratio of the total length of all-weather roads to the total land area in a given woreda; the unit is meters of road per square kilometer of land.
- road density, all types (woreda ratio): this variable is the ratio of the total length of all road types to the total land area in a given woreda; the unit is meters of road per square kilometer of land.
- road density, all-weather (local filter): this variable is mean woreda value of pixel values, where the pixel size is 1 square kilometer, and the value is the ratio of the total length of all-weather roads within 10 kilometers, over the total search area (about 317 square kilometers). This measure differs from the woreda ratio measure in that it incorporates the effects of roads immediately outside a woreda's boundary.
- road density, all types (local filter): this variable is mean woreda value of pixel values, where the pixel size is 1 square kilometer, and the value is the ratio of the total length of roads within 10 kilometers, over the total search area (about 317 square kilometers). This measure differs from the woreda ratio measure in that it incorporates the effects of roads immediately outside a woreda's boundary.
- All of these indicators were used as candidate variables for market access in the present work, although none were used in the final domain definitions.

Interaction Model Output

Gravity or *potential interaction* models are efforts to capture the relative "attraction" of different centers of activity or exchange (such as markets). This approach has been implemented using town population or other criteria to assign a relative "pull" on potential market participants (e.g. Deichmann 1997). There are several ways to implement this mathematically. The variable we use in this work is an index based on a town's population, which is then decayed over time-space using a variation of the classical distance decay function:

Ai = Wj / (dij ^ b)

where:

Ai accessibility value for cell i

Wj weight of node j (in this case, population)

dij travel time between node i and j

b distance decay exponent (2 is used here)

Thus, the indicator is an index that combines town size and distance from that town. The average woreda value of this indicator was used as a candidate variable for market access in the present work, although was not used in the final domain definitions.

III. Population Density

The data on population was estimated at the woreda level by the Central Statistics Authority for the year 2004. These estimates were based on woreda level population counts from the 1994 Census, updated on the basis of growth rates defined by CSA at the Regional level. We acknowledge that the methodology used may have unresolved inference issues associated with it.

Population density was calculated within a geographic information system, using total land area as the base variable.

IV. Outcome Variables

We considered a wide range of outcome variables, and finally settled on the following:

cash crop prevalence

- ★ coffee – average share of total crop area
- ★ chat – average share of total crop area
- ★ oilseeds – average share of total crop area
- ★ vegetables – average share of total crop area

market participation

- ★ cereals – % of household production which is marketed
- ★ root crops – % of household production which is marketed
- ★ vegetables – % of household production which is marketed
- ★ oilseeds – % of household production which is marketed
- ★ pulses – % of household production which is marketed

off-farm employment prevalence

- ★ % of workforce fully dependent on agriculture
- ★ % of workforce engaged part-time in agriculture
- ★ % of workforce engaged primarily in non-farm employment

Livestock dependence

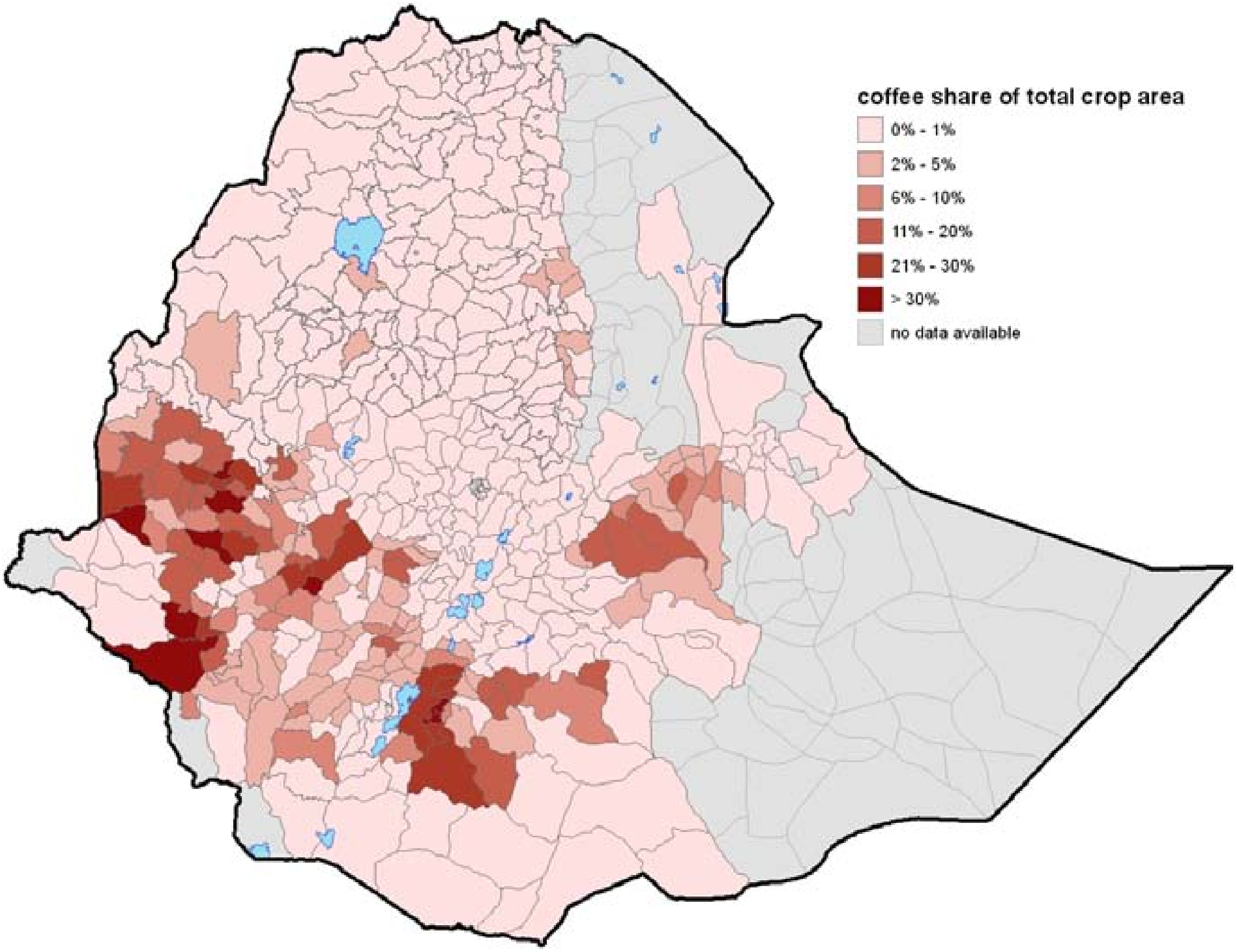
- ★ cattle – average herd size (# of animals per holder)
- ★ sheep – average herd size (# of animals per holder)
- ★ goats – average herd size (# of animals per holder)

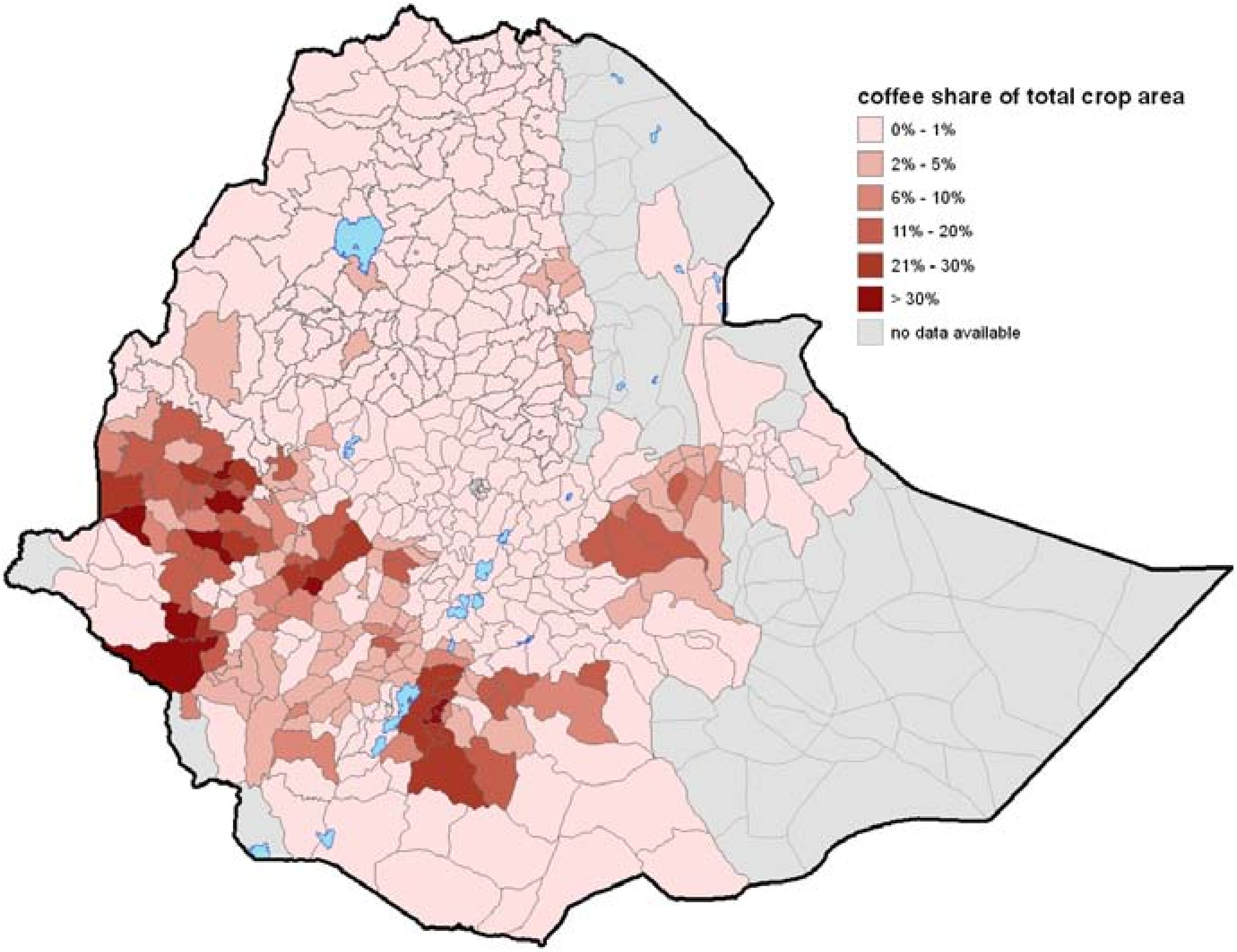
All of these variables were available at the woreda level, from the 2001-2002 Ethiopian Agricultural Sample Survey (EASE, commonly referred to as the "Agricultural Census"). While we would have preferred to use data covering a wider time period, we used these data because of their availability at the woreda level. We note that the time period covered by the EASE was a relatively "normal" production year.

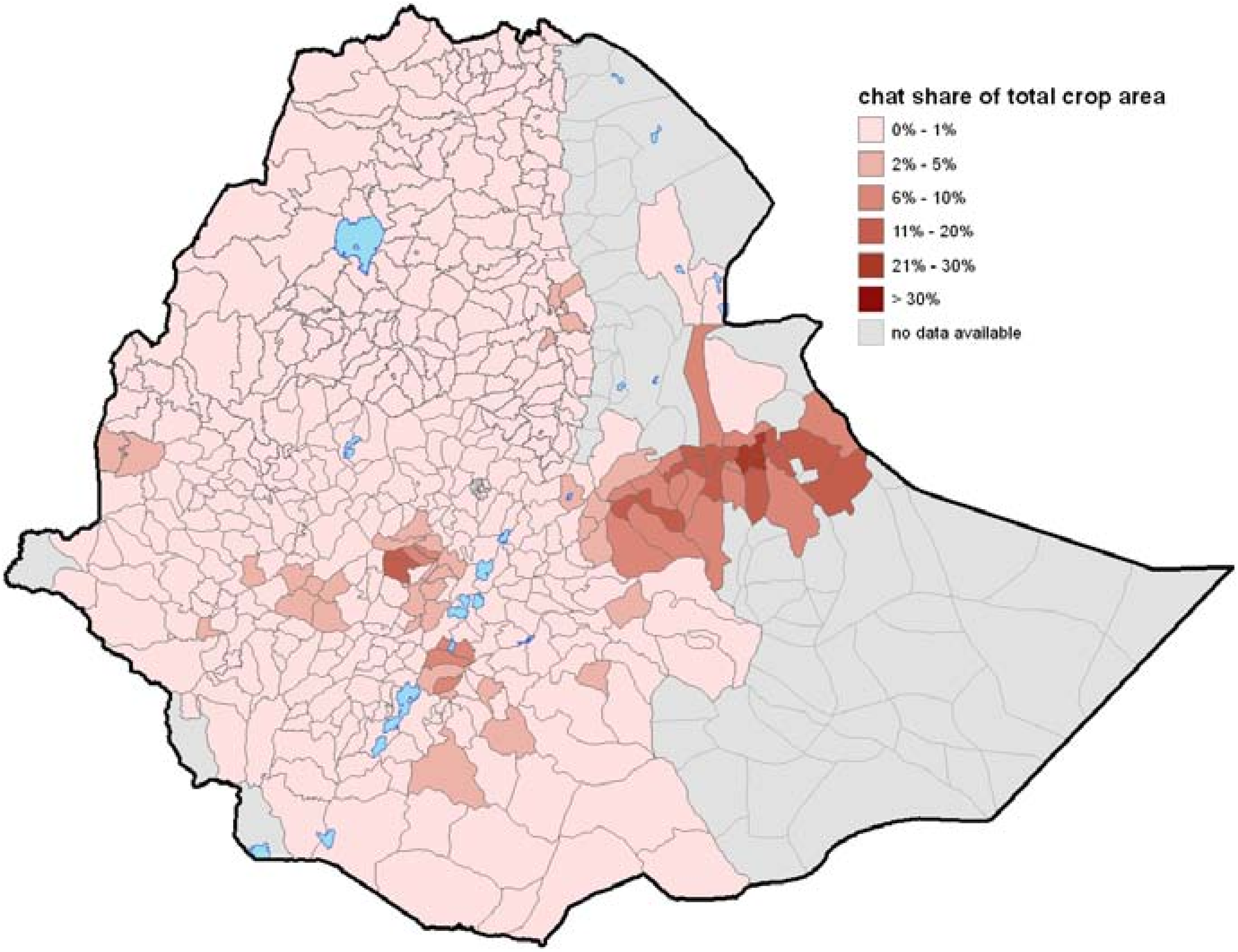
Some of the variables that we would have liked to use were not available to us immediately or at the level of disaggregation that would have enabled woreda-level analysis.

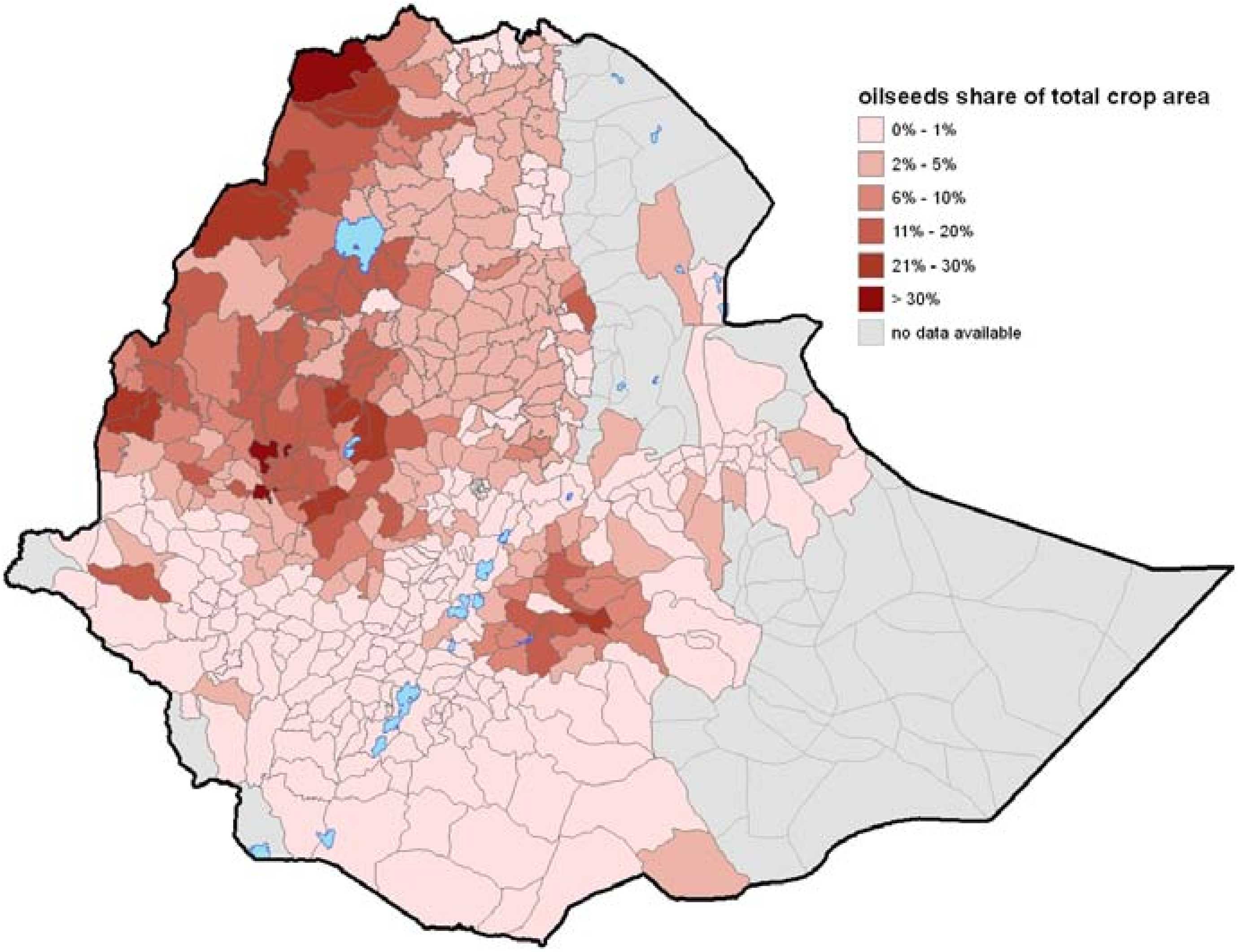
APPENDIX 3

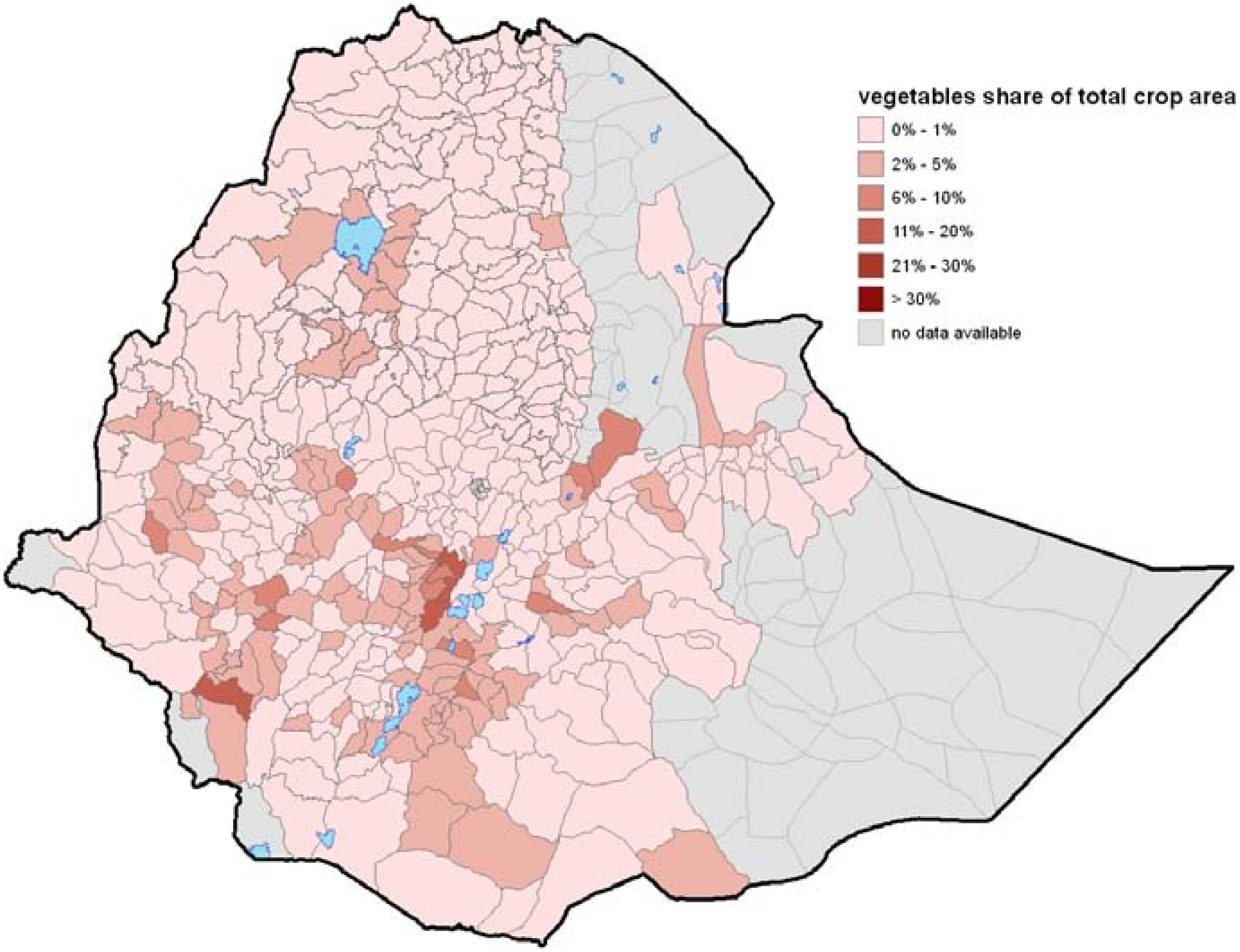
Mapped Outcome Variables

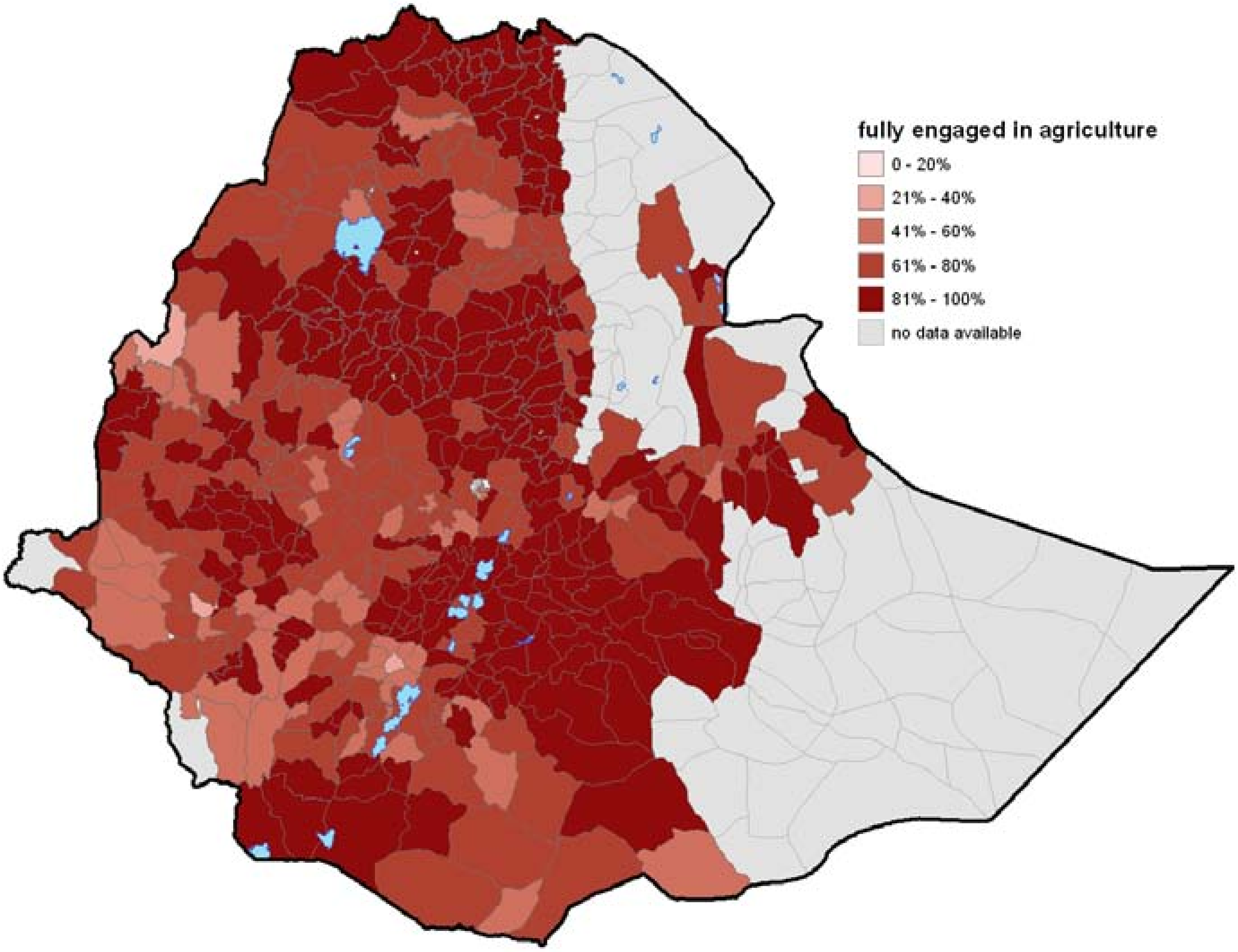


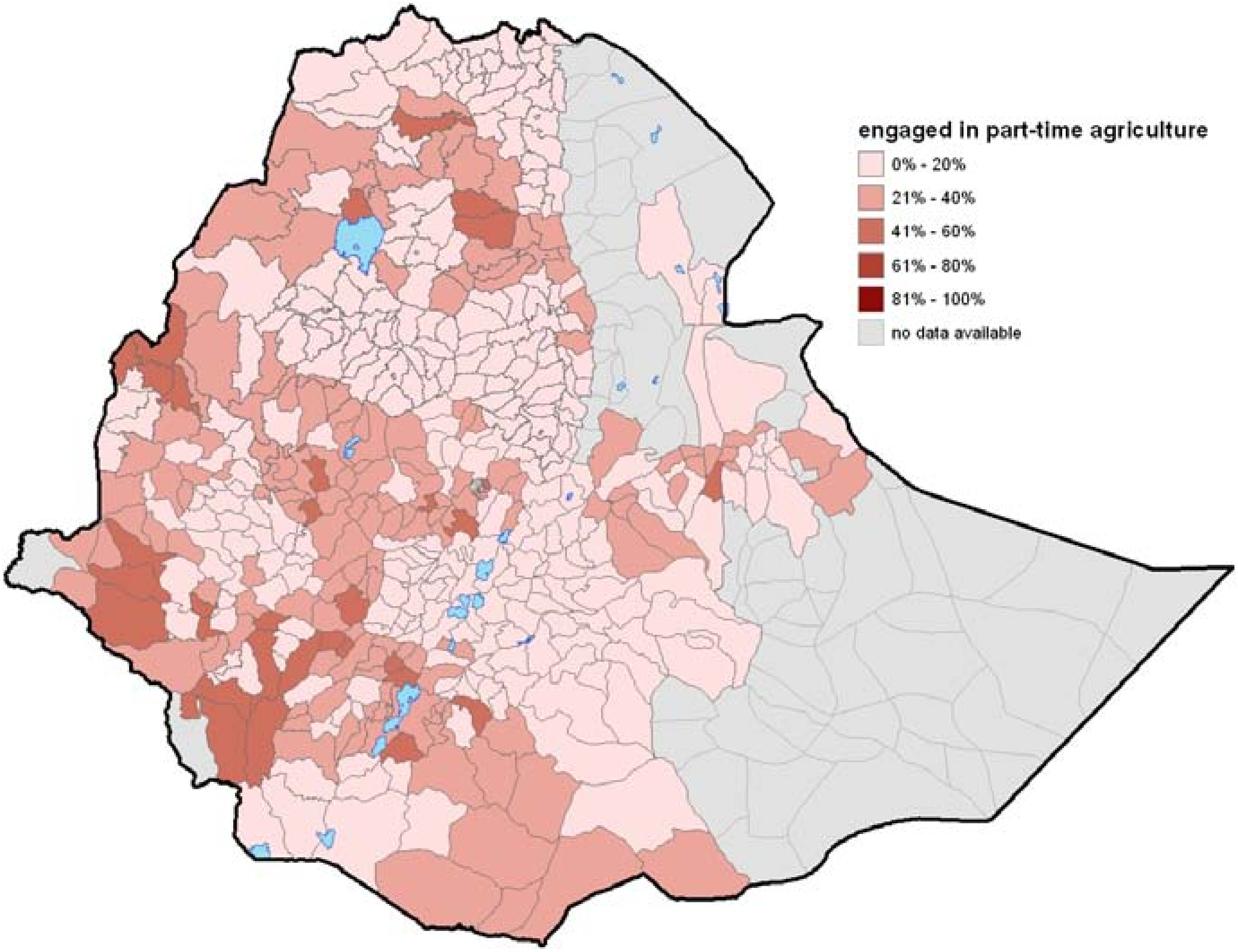

coffee share of total crop area
0% - 1%
2% - 5%
6% - 10%
11% - 20%
21% - 30%
> 30%
no data available


chat share of total crop area
0% - 1%
2% - 5%
6% - 10%
11% - 20%
21% - 30%
> 30%
no data available

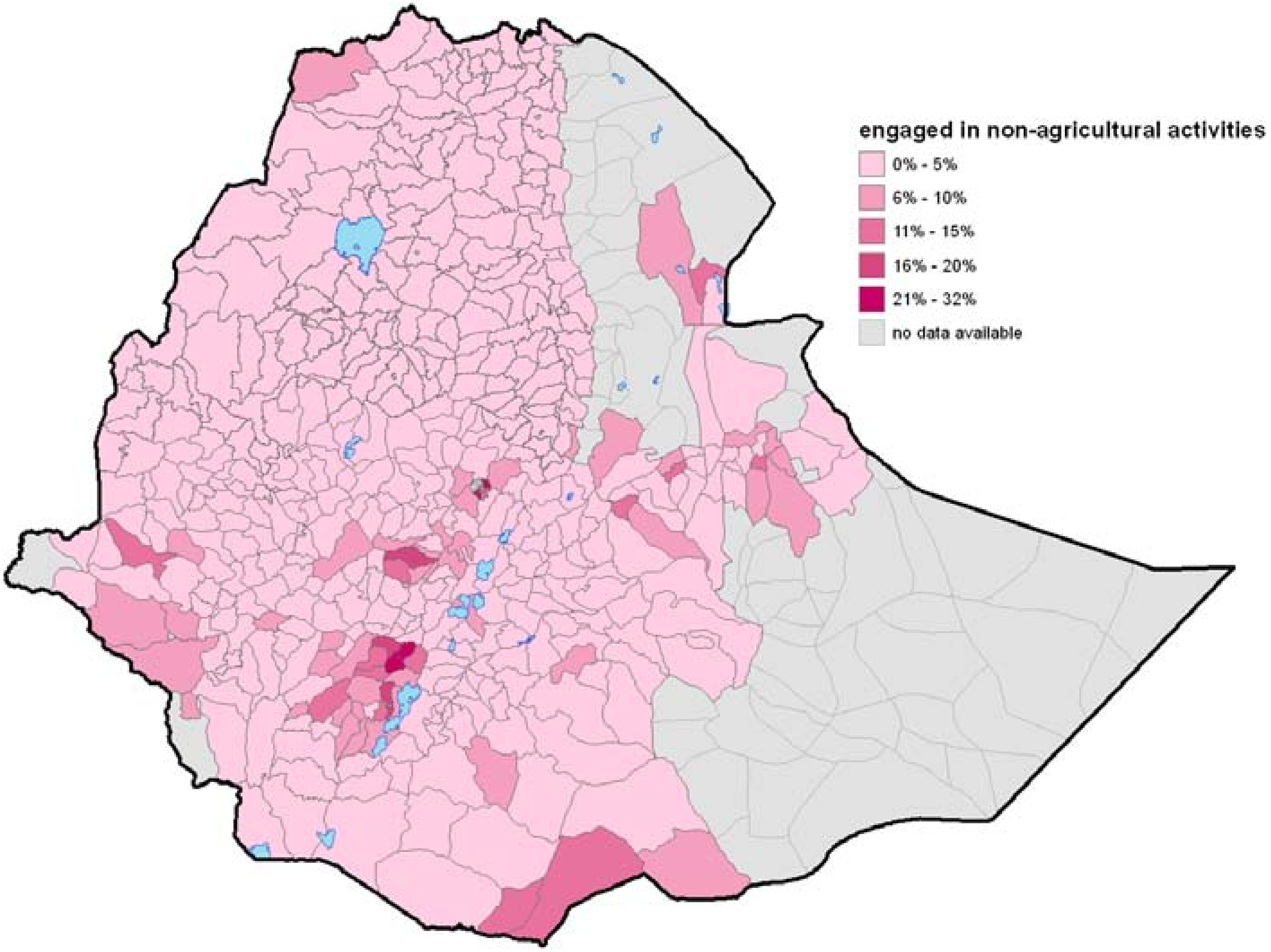

oilseeds share of total crop area
0% - 1%
2% - 5%
6% - 10%
11% - 20%
21% - 30%
> 30%
no data available

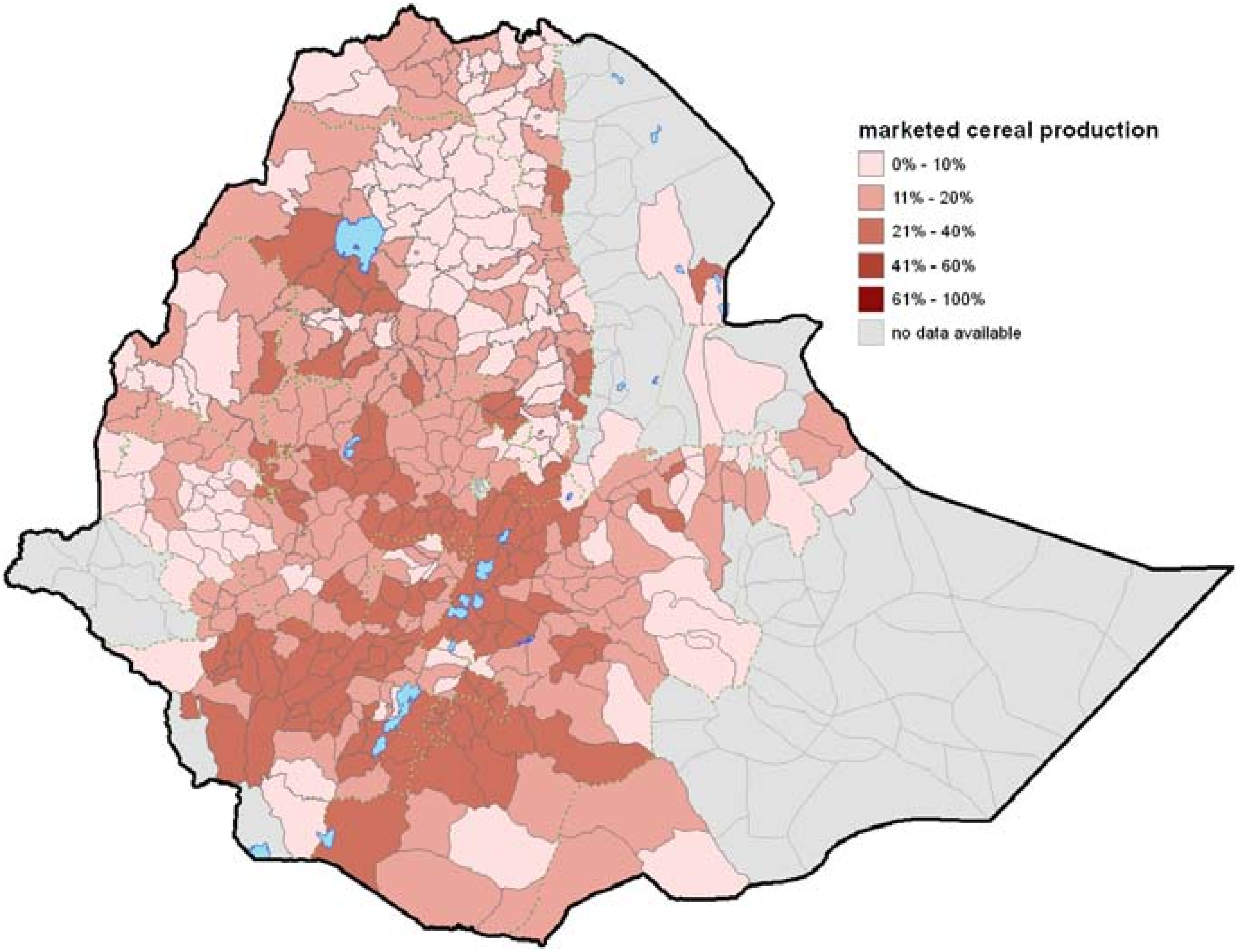

vegetables share of total crop area
0% - 1%
2% - 5%
6% - 10%
11% - 20%
21% - 30%
> 30%
no data available

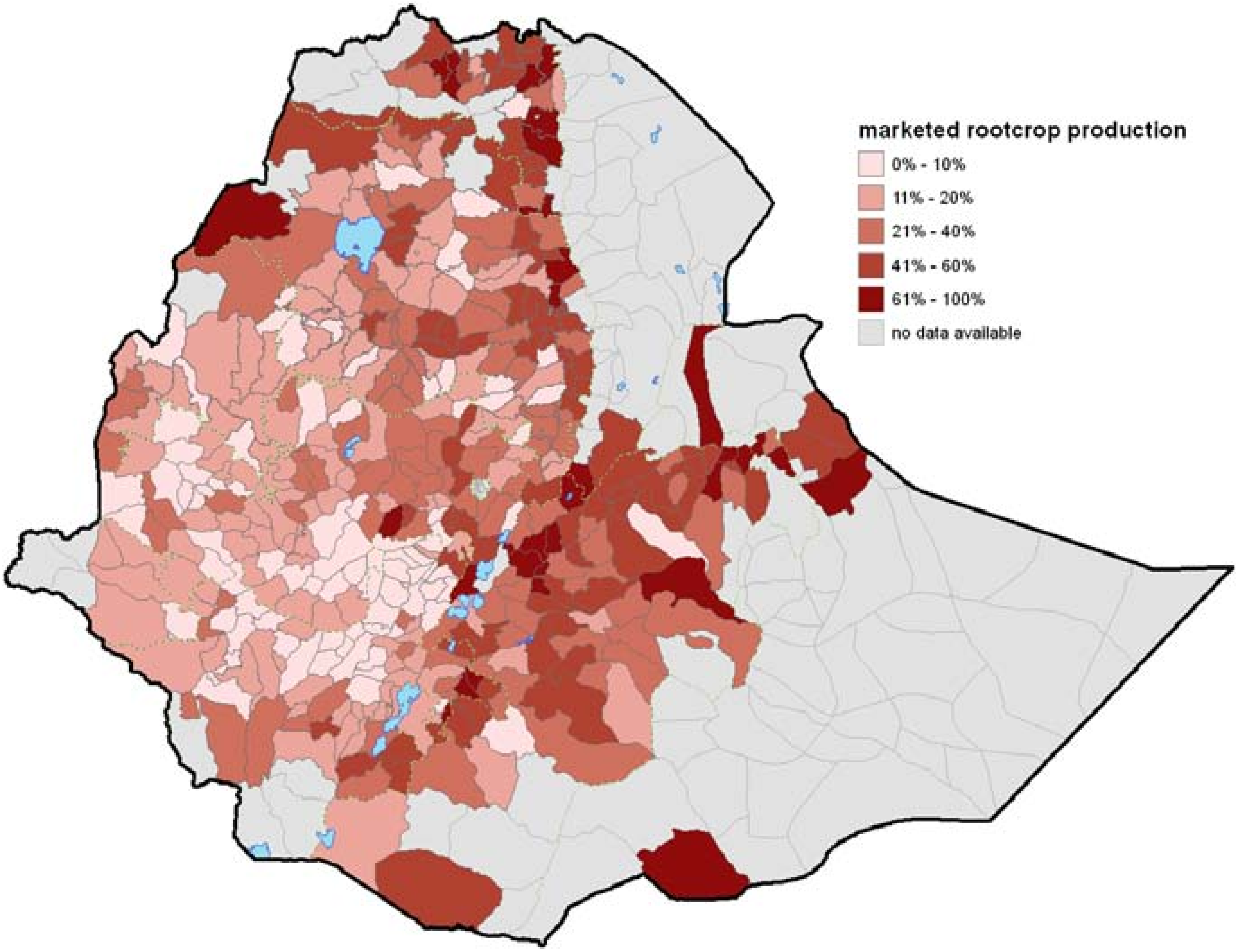

fully engaged in agriculture
0 - 20%
21% - 40%
41% - 60%
61% - 80%
81% - 100%
no data available

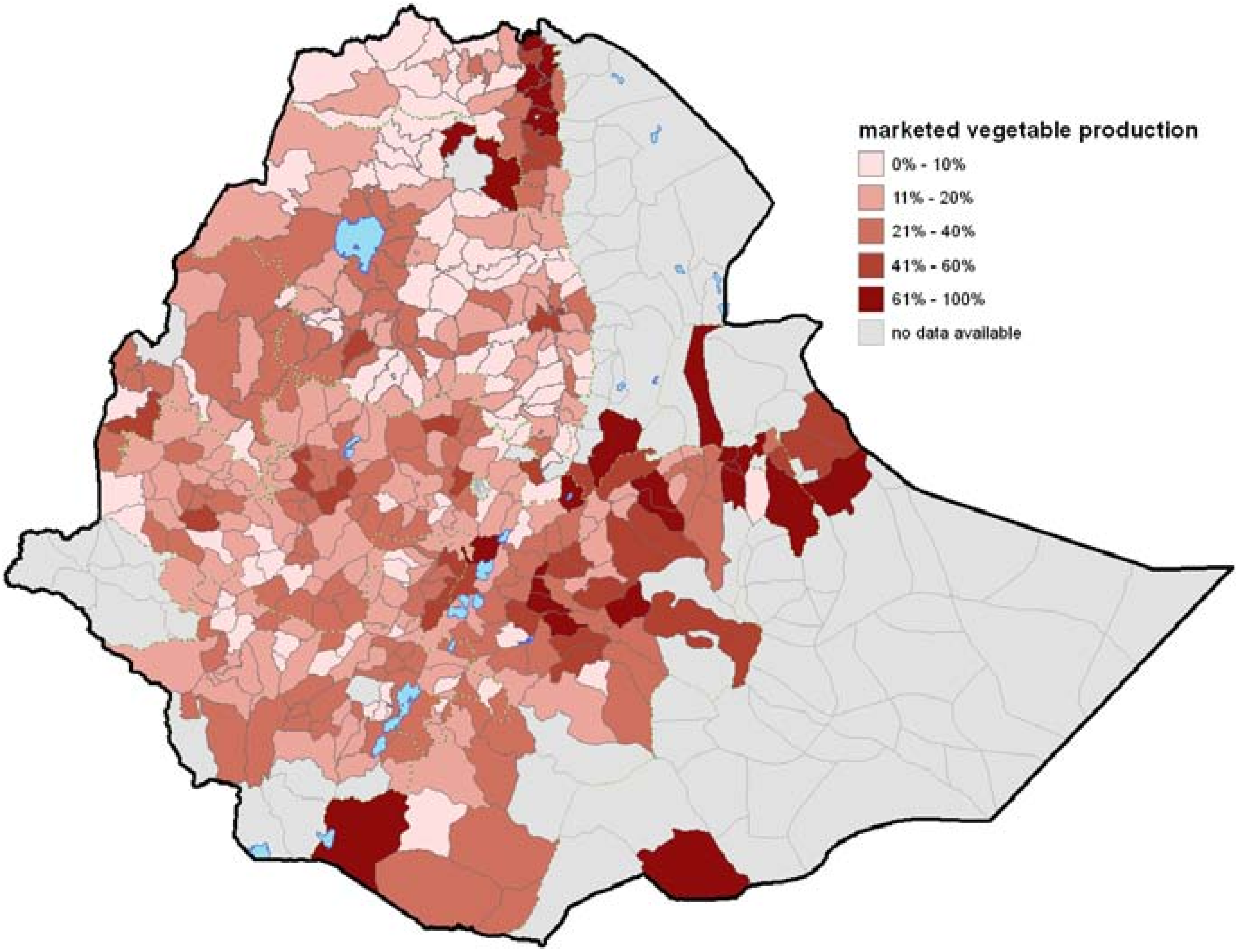


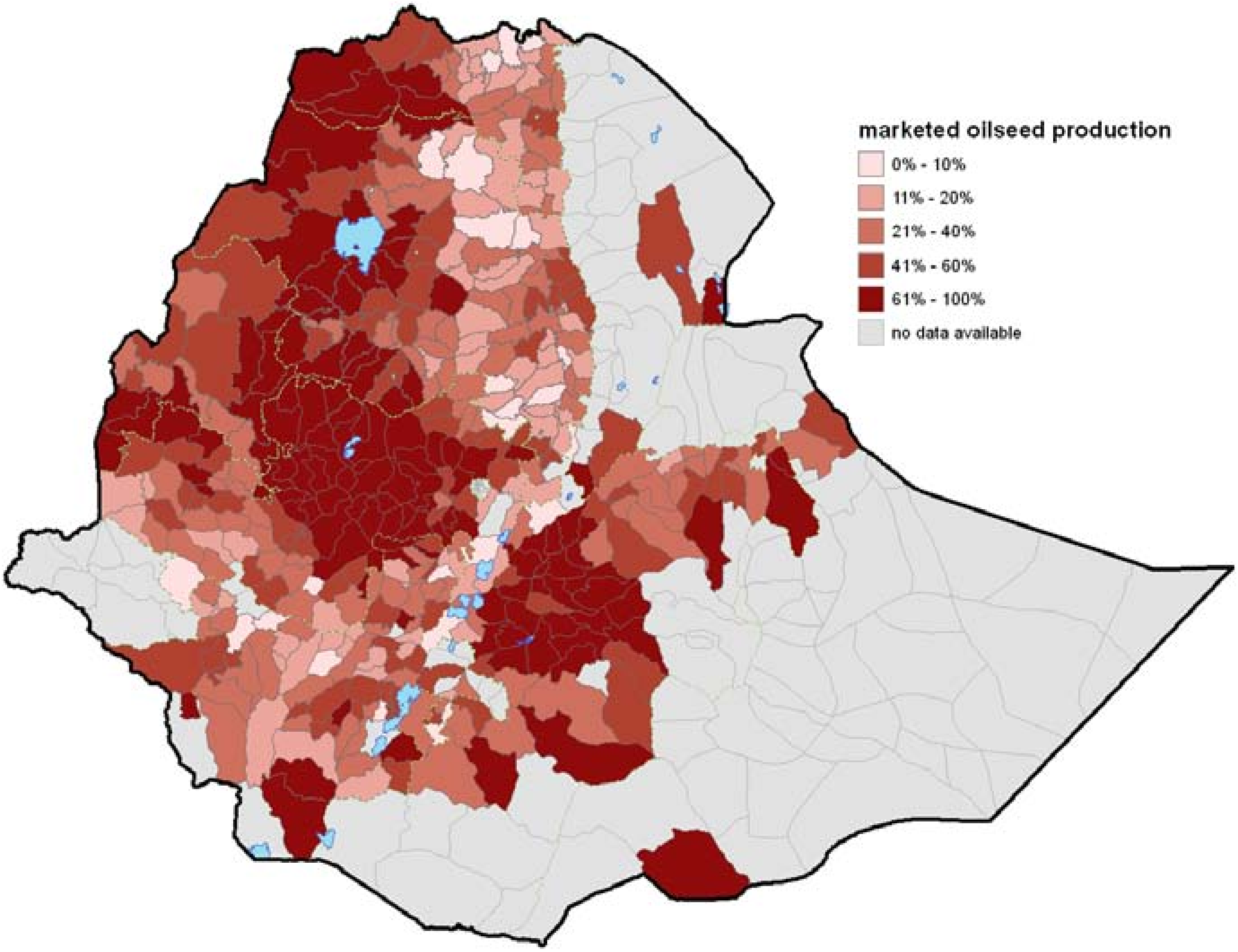
engaged in part-time agriculture
0% - 20%
21% - 40%
41% - 60%
61% - 80%
81% - 100%
no data available

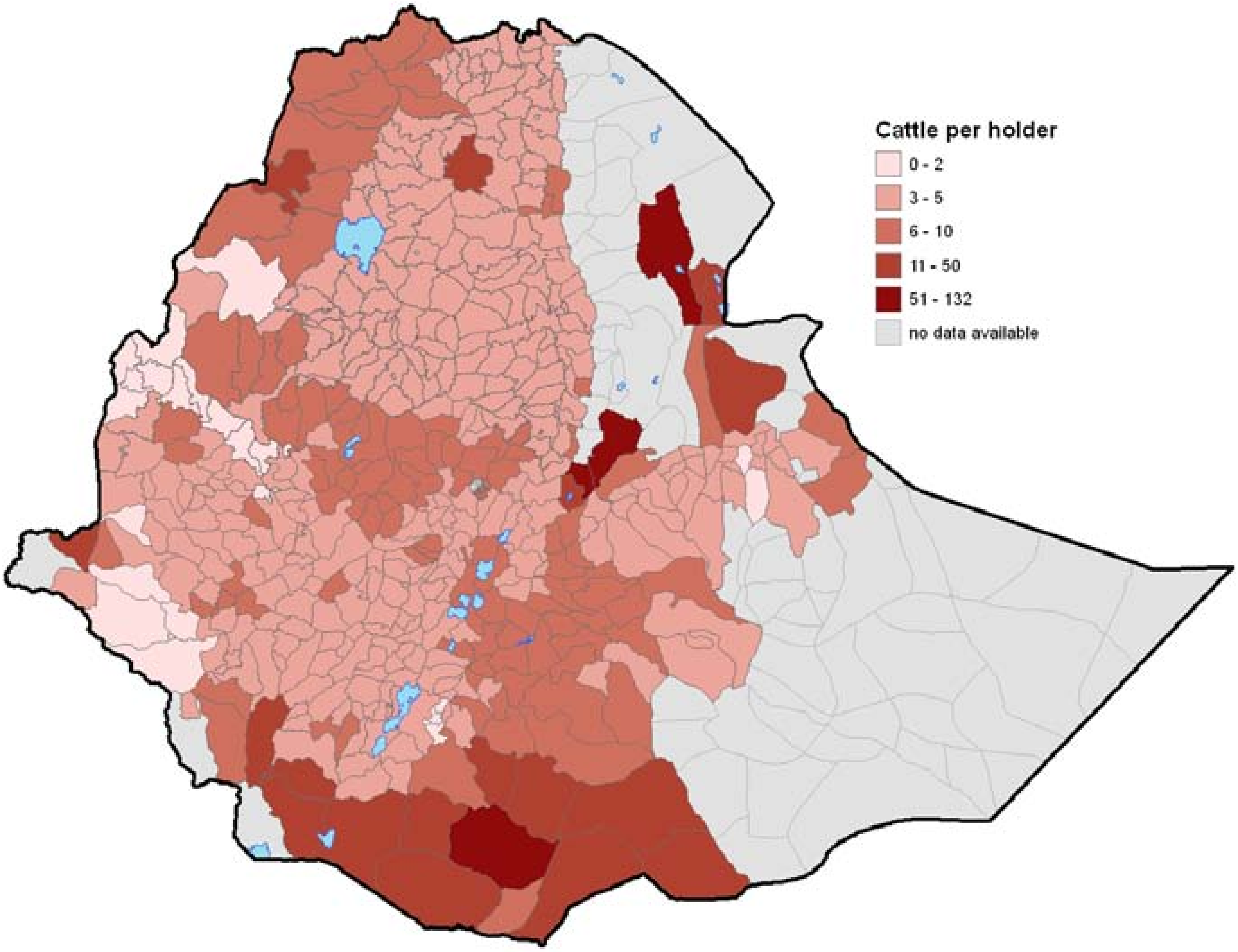

engaged in non-agricultural activities
0% - 5%
6% - 10%
11% - 15%
16% - 20%
21% - 32%
no data available

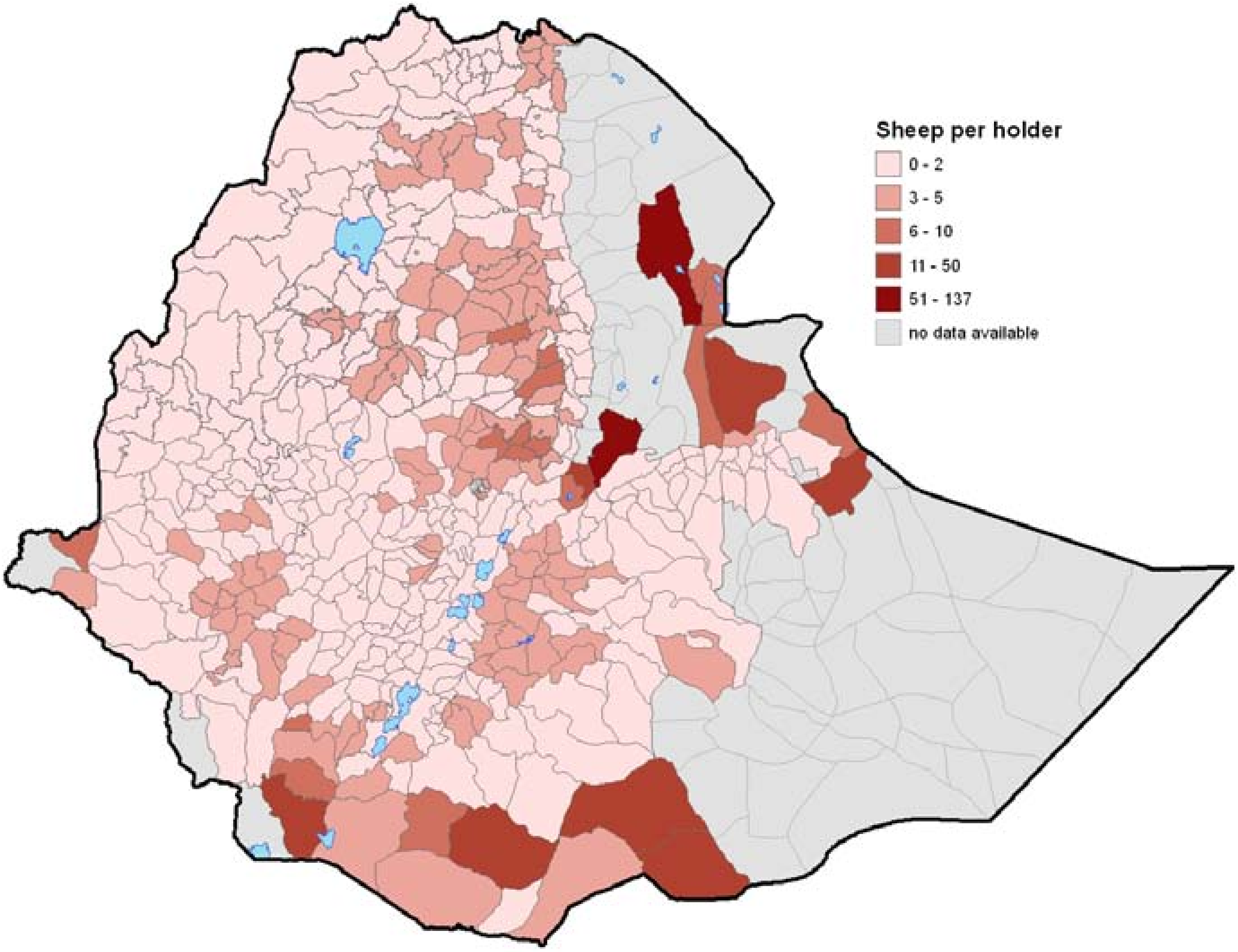

marketed cereal production
0% - 10%
11% - 20%
21% - 40%
41% - 60%
61% - 100%
no data available

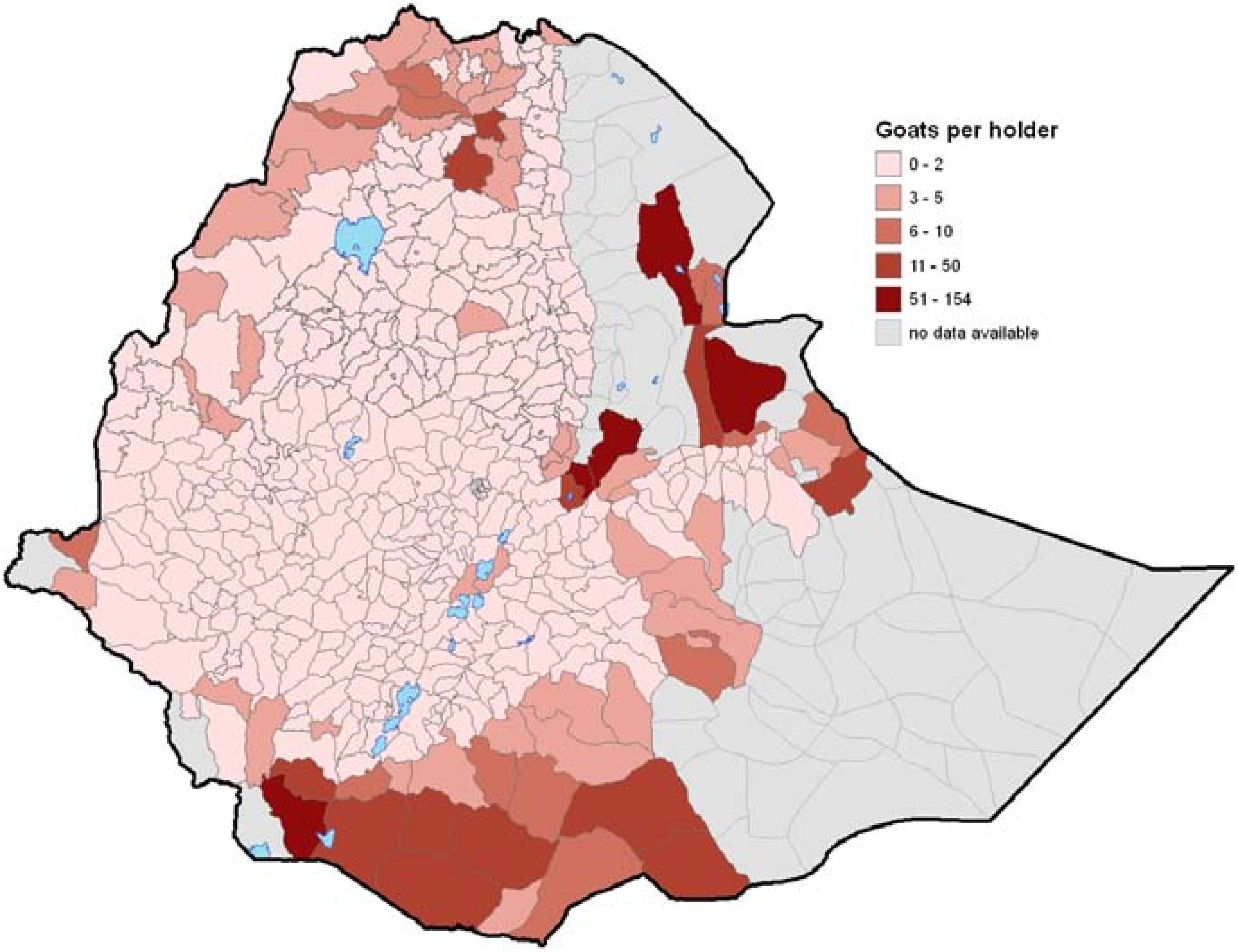

marketed rootcrop production
0% - 10%
11% - 20%
21% - 40%
41% - 60%
61% - 100%
no data available


marketed vegetable production
0% - 10%
11% - 20%
21% - 40%
41% - 60%
61% - 100%
no data available


marketed oilseed production
0% - 10%
11% - 20%
21% - 40%
41% - 60%
61% - 100%
no data available


Cattle per holder
0 - 2
3 - 5
6 - 10
11 - 50
51 - 132
no data available


Sheep per holder
0 - 2
3 - 5
6 - 10
11 - 50
51 - 137
no data available


Goats per holder
0 - 2
3 - 5
6 - 10
11 - 50
51 - 154
no data available

APPENDIX 4

Consultations with experts on the implementation of development domains in Ethiopia

This section provide more information about the consultative process used to help refine implementation of the development domain concepts in Ethiopia. A series of meetings was convened during the latter half of 2005 to engage Ethiopian development experts in discussion with the following aims:

- ★ To ratify the conceptual basis underlying development domains for Ethiopian smallholder livelihoods and rural development options
- ★ To determine how best to represent development domains in Ethiopia, e.g.
- o how to best represent agricultural potential, market access and population density
- o what mapped categories best reflect national realities ("high-low", "high-med-low" etc.)
- ★ To review available and relevant spatial datasets in terms of appropriateness, spatial and temporal scale, and quality

During these meetings, in addition to discussions, printed maps of different variables of potential relevance were reviewed, as were alternative mapped candidate definitions of composite development domains.

Experts were invited from government entities at national and regional levels, research and academic institutions, non-governmental organizations and the private sector. The authors thank the following individuals for their generous and valuable participation:

Dr. Fantaw Abegaz, Ethiopian Agricultural Research Organization, Addis Ababa
Mr. Michael Shiferaw, Addis Ababa University, Dept. of Geography, Addis Ababa
Mr. Lakew Desta, Ministry of Agriculture and Rural Development, Addis Ababa
Dr. Bezabih Emana, Walid PLC, Addis Ababa
Mr. Berihun Tefera, Ethiopian Agricultural Research Organization, Melkassa

Mr. Tesfaye Gissila, National Meteorological Services Agency, Addis Ababa
Dr. Dawit Alemu, Ethiopian Agricultural Research Organization, Melkassa
Dr. Edilegnaw Wale, Alemaya University, Dept. of Economics, Alemaya
Dr. Abayneh Esayas, National Soils Laboratory, Addis Ababa
Dr. Gete Zeleke, Ethiopian Development Research Institute, Addis Ababa
Dr. Gezahegn Ayele, Ethiopian Development Research Institute, Addis Ababa
Mr. Makkonen Bekele, Ethiopian Development Research Institute, Addis Ababa
Mr. Kassu Wamisho, International Food Policy Research Institute, Addis Ababa
Dr. Berhanu Gebre-Medhin, International Livestock Research Institute, Addis Ababa
Mr. Noah Kebede, International Livestock Research Institute, Addis Ababa
Dr. Alemayehu Seyoum, Ethiopian Economic Association, Addis Ababa
Mr. Atesmachew Bizuwerk, UN Office of Humanitarian Affairs, Addis Ababa
Mr. Kedir Shemsu, World Food Programme, Addis Ababa
Mr. Shenkut Ayele, Ethiopian Agricultural Research Organization, Holeta
Dr. Tsedeke Abate, Ethiopian Agricultural Research Organization, Addis Ababa
Dr. Kidane Georgis, Ethiopian Agricultural Research Organization, Addis Ababa
Mr. Taye Bekele, Ethiopian Agricultural Research Organization, Addis Ababa
Mr. Melaku Zenata, Ministry of Agriculture and Rural Development, Addis Ababa

In addition, many others provided helpful and informative feedback through individual and less formal consultations and reviews of previous drafts of this paper.

LIST OF DSGD DISCUSSION PAPERS

42. *Exploring Growth Linkages and Market Opportunities for Agriculture in Southern Africa* by Alejandro Nin Pratt and Xinshen Diao, September 2006

41. *A Multi-level Analysis of Public Spending, Growth and Poverty Reduction in Egypt* by Shenggen Fan, Perrihan Al-Riffai, Moataz El-Said, Bingxin Yu, and Ahmed Kamaly, September 2006

40. *Assessing Potential Impact of Avian Influenza on Poultry in West Africa – A Spatial Equilibrium Model Analysis* by Liangzhi You and Xinshen Diao, September 2006

39. *Agricultural Trade Liberalization Under Doha: The Risks Facing African Countries* by Ousmane Badiane, September 2006

38. *Shocks, Livestock Asset Dynamics and Social Capital in Ethiopia* by Tewodaj Mogues, August 2006

37. *From "Best Practice" to Best Fit": A Framework for Analyzing Pluralistic Agricultural Advisory Services Worldwide* by Regina Birner, Kristin Davis, John Pender, Ephraim Nkonya, Ponniah Anandajayasekeram, Javier Ekboir, Adiel Mbabu, David J. Spielman, Daniela Horna, Samuel Benin, and Marc Cohen, August 2006

36. *Has Trade Liberalization in South Africa Affected Men and Women Differently?* by James Thurlow, July 2006

35. *Public Investment to Reverse Dutch Disease: The Case of Chad* by Stephanie Levy, June 2006

34. *Moving Up and Down: A New Way of Examining Country Growth Dynamics* by Marc Rockmore and Xiaobo Zhang, June 2006

33. *Trade Liberalization under CAFTA: An Analysis of the Agreement with Special Reference to Agriculture and Smallholders in Central America* by Sam Morley, May 2006

32. *Shocks, Sensitivity and Resilience: Tracking the Economic Impacts of Environmental Disaster on Assets in Ethiopia and Honduras* by Michael R. Carter, Peter D. Little, Tewodaj Mogues, and Workneh Negatu**,** April 2006

31. *Village Inequality in Western China: Implications for Development Strategy in Lagging Regions* by Li Xing, Shenggen Fan, Xiaopeng Luo, and Xiaobo Zhang, February 2006

30. *Does Good Governance Contribute to Pro-poor Growth?: A Review of the Evidence from Cross-Country Studies* by Danielle Resnick and Regina Birner (February 2006)

29. *The Role of Agriculture in Development: Implications for Sub-Saharan Africa* by Xinshen Diao, Peter Hazell, Danielle Resnick, and James Thurlow, February 2006

28. *Asymmetric Property Rights in China's Economic Growth* by Xiaobo Zhang, January 2006

27. *Determinants of Change in Household-Level Consumption and Poverty in Uganda, 1992/93-1999/00* by Sam Benin and Samuel Mugarura, January 2006

26. *Geographic Space, Assets, Livelihoods and Well-being in Rural Central America: Empirical Evidence from Guatemala, Honduras and Nicaragua* by Jeffrey Alwang, Hans G.P. Jansen, Paul B. Siegel and Francisco Pichon, November 2005

25. *Social Capital and the Reproduction of Economic Inequality in Polarized Societies* by Tewodaj Mogues and Michael R. Carter, November 2005

24. *Rural Nonfarm Development in China and India: The Role of Policies and Institutions* by Anit Mukherjee and Xiaobo Zhang, September 2005

23. *Rural and Urban Dynamics and Poverty: Evidence from China and* India by Shenggen Fan, Connie Chan-Kang and Anit Mukherjee, August 2005

22. *The Dragon and the Elephant: Agricultural and Rural Reforms in China and India* by Ashok Gulati, Shenggen Fan and Sara Dalafi, August 2005

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20. *Growth Options and Poverty Reduction in Ethiopia: A Spatial, Economywide Model Analysis for 2004-15* by Xinshen Diao and Alejandro Nin Pratt with Madhur Gautam, James Keough, Jordan Chamberlin, Liangzhi You, Detlev Puetz, Danille Resnick and Bingxi Yu, May 2005

19. *Identifying the Drivers of Sustainable Rural Growth and Poverty Reduction in Honduras* by Hans G.P. Jansen, Paul B. Siegel and Francisco Pichón, April 2005

18. *Public Investment and Poverty Reduction in Tanzania: Evidence from Household Survey Data* by Shenggen Fan, David Nyange and Neetha Rao, April 2005

17. *Achieving Regional Growth Dynamics in African Agriculture* by Awudu Abdulai, Xinshen Diao and Michael Johnson, January 2005

16. *The Road to Pro-poor Growth in Zambia: Past Lessons and Future Challenges* by James Thurlow and Peter Wobst, December 2004

15. *Institutions and Economic Policies for Pro-poor Agricultural Growth* by Andrew Dorward, Shenggen Fan, Jonathan Kydd, Hans Lofgren, Jamie Morrison, Colin Poulton, Neetha Rao, Laurence Smith, Hardwick Tchale, Sukhadeo Thorat, Ian Urey, and Peter Wobst, November 2004

14. *Strategic Analysis and Knowledge Support Systems for Rural Development Strategies in Sub-Saharan Africa* by Michael Johnson and Danielle Resnick, with Simon Bolwig, Jordan Chamberlin, Liangzhi You, Stanley Wood, and Peter Hazell, October 2004

13. *Blunt to Sharpened Razor: Incremental Reform and Distortions in the Product and Capital Markets in China* by Xiaobo Zhang and Kong-Yam Tan, August 2004

12. *Road Development, Economic Growth, and Poverty Reduction in China* by Shenggen Fan and Connie Chan-Kang, August 2004

11. *Prospects for Growth and Poverty Reduction in Zambia, 2001-2015* by Hans Lofgren, James Thurlow, and Sherman Robinson, August 2004

10. *Bridging Research, Policy, and Practice in African Agriculture* by Steven Were Omamo, July 2004

9. *Smallholder African Agriculture: Progress and Problems in Confronting Hunger and Poverty* by Danielle Resnick, July 2004

8. *Cross-Country Typologies and Development Strategies to End Hunger in Africa* by Xiaobo Zhang, Michael Johnson, Danielle Resnick, and Sherman Robinson, June 2004

7. *The Importance of Public Investment for Reducing Rural Poverty in Middle-income Countries: The Case of Thailand* by Shenggen Fan, Somchai Jitsuchon, and Nuntaporn Methakunnavut, June 2004

6. *Security Is Like Oxygen: Evidence from Uganda* by Xiaobo Zhang, May 2004

5. *Food Aid for Market Development in Sub-Saharan Africa* by Awudu Abdulai, Christopher B. Barrett, and Peter Hazell, April 2004

4. *Public Expenditure, Growth, and Poverty Reduction in Rural* Uganda by Shenggen Fan, Xiaobo Zhang, and Neetha Rao, March 2004

3. *The Effect of WTO and FTAA on Agriculture and the Rural Sector in Latin America* by Samuel Morley and Valeria Piñeiro, February 2004

2. *Exploring Regional Dynamics in Sub-Saharan African Agriculture* by Xinshen Diao and Yukitsugu Yanoma, October 2003

1. *Market Opportunities for African Agriculture: An Examination of Demand-Side Constraints on Agricultural Growth* by Xinshen Diao, Paul Dorosh, and Shaikh Mahfuzur Rahman with Siet Meijer, Mark Rosegrant, Yukitsugu Yanoma, and Weibo Li, September 2003