B A S I S

Broadening Access and Strengthening Input Market Systems

The geographic dimensions of food security in South Wello:

A preliminary analysis of survey data from 'Round 4 (November/December 2001)' using geographic information systems (GIS) and global positioning systems (GPS)

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I. Introduction

A geographic perspective is used to examine data collected from the fourth round (R4—November/December 2001) of the BASIS household study conducted in South Wello, Ethiopia. This report represents a preliminary analysis of the survey data, with particular emphasis placed upon the geographic dimensions of survey responses. By linking geographic coordinate data obtained from global positioning systems (GPS) with geographic information systems (GIS), survey responses are situated within several geographic contexts and the spatial patterns underlying survey responses are revealed. The results from this preliminary analysis inform ongoing research regarding food security and income entitlements, and provide useful information with regard to future research strategies and programs within South Wello.

Questions motivating this geographic analysis of the R4 data include:

- What are the geographic dimensions of the survey strategy?
- How does food security vary across South Wello, as well as locally?
- How does access to physical capital vary across the study area?

This report is divided into two complementary parts. Part I provides a general overview of the study area and locates the survey sites within South Wello and Oromiya zones. Part II looks at local patterns of food security and physical capital. All figures were created with ArcView 3.2 GIS distributed by Environmental Systems Research, Inc., and can be obtained separately from this report as Windows metafiles upon request from the author.

I. The geographic context of South Wello

Linking geographic coordinates (i.e., latitude and longitude) obtained with global positioning systems to individual household survey sites provides a useful and innovative way to analyze R4 survey data throughout South Wello and Oromiya study area. The coordinate data permit the coupling of survey data with pre-existing maps and geographic databases, as well as the creation of new data. Through the use of geographic information systems (GIS), R4 survey responses are situated within a broader geographic context and spatial patterns and relationships that exist between survey sites are explored and examined further.

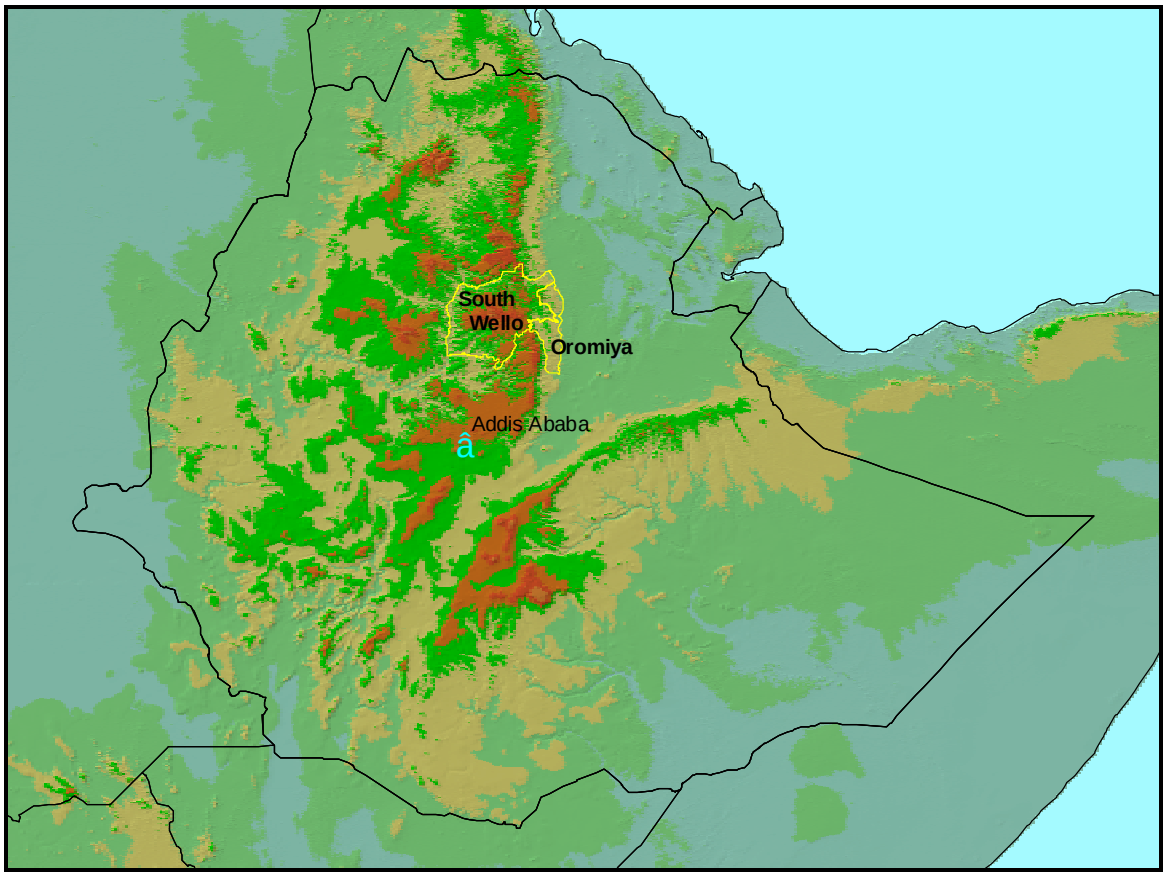

Figure 1. Surface relief map of Ethiopia and study area, derived from a 1-km digital elevation model.

The R4 survey was administered in South Wello and Oromiya zones, along the eastern portion of the Amhara region of Ethiopia. The study area contains a wide range of geographic settings from lowland areas on the eastern edge of Oromiya to the central highlands of South Wello. Figure 1 overlays the borders of South Wello and Oromiya zones onto a surface relief map of Ethiopia that was derived from a 1-kilometer resolution digital elevation model (DEM). Digital elevation models contain regularly spaced terrain elevation measurements, in this case, at one-square kilometer intervals. In Figure 1, areas at lower elevations (i.e., < 2000 meters) are represented by shades of green and highland areas (i.e., > 3800 meters) are represented by shades of brown. This map illustrates clearly the variation of terrain and elevation found throughout the study area, and permits comparison with other regions of Ethiopia and the Horn of Africa.

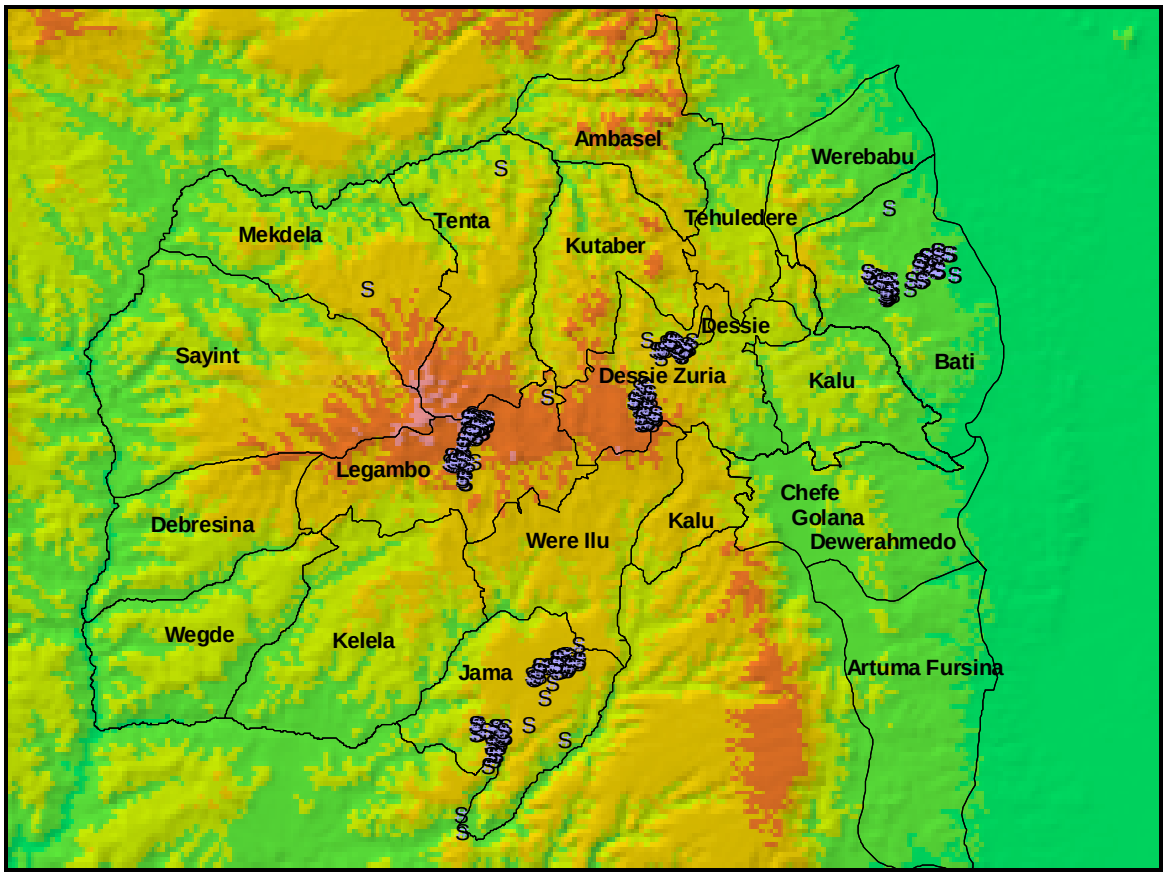

Figure 2. *Woredas* and R4 survey sites in South Wello and Oromiya zones of Ethiopia.

Looking specifically at the study area, Figure 2 plots each of the survey sites as a blue circle on the shaded relief map. At this particular scale the map is pixilated, thus revealing the one-kilometer resolution of the DEM. Overlayed onto this image are the *woredas* of South Wello and Oromiya zones. It is unclear whether or not the survey sites that fall outside of the four *woredas* of Bati, Dessie Zuria, Legambo and Jama are GPS errors, data input errors or whether surveys were indeed administered in these outlying locations. The mapping of survey sites in this fashion illustrates the utility of GPS and GIS as a tool for data verification and error checking.

Geographic coordinates were obtained in 413 of the 423 survey sites. The map in Figure 2 illustrates that the survey covers the agroecological zones found across the study area. Specifically, Dessie Zuria and Legambo are considered *dega* or highland *woredas*, Jama is a midland or *woina dega woreda* and the lowland or *kolla* is represented by the *woreda* of Bati. Based upon historical data, the *woredas* of Dessie Zuria, Legambo and Bati tend to experience food-deficits, and only Jama is considered a food-surplus location .

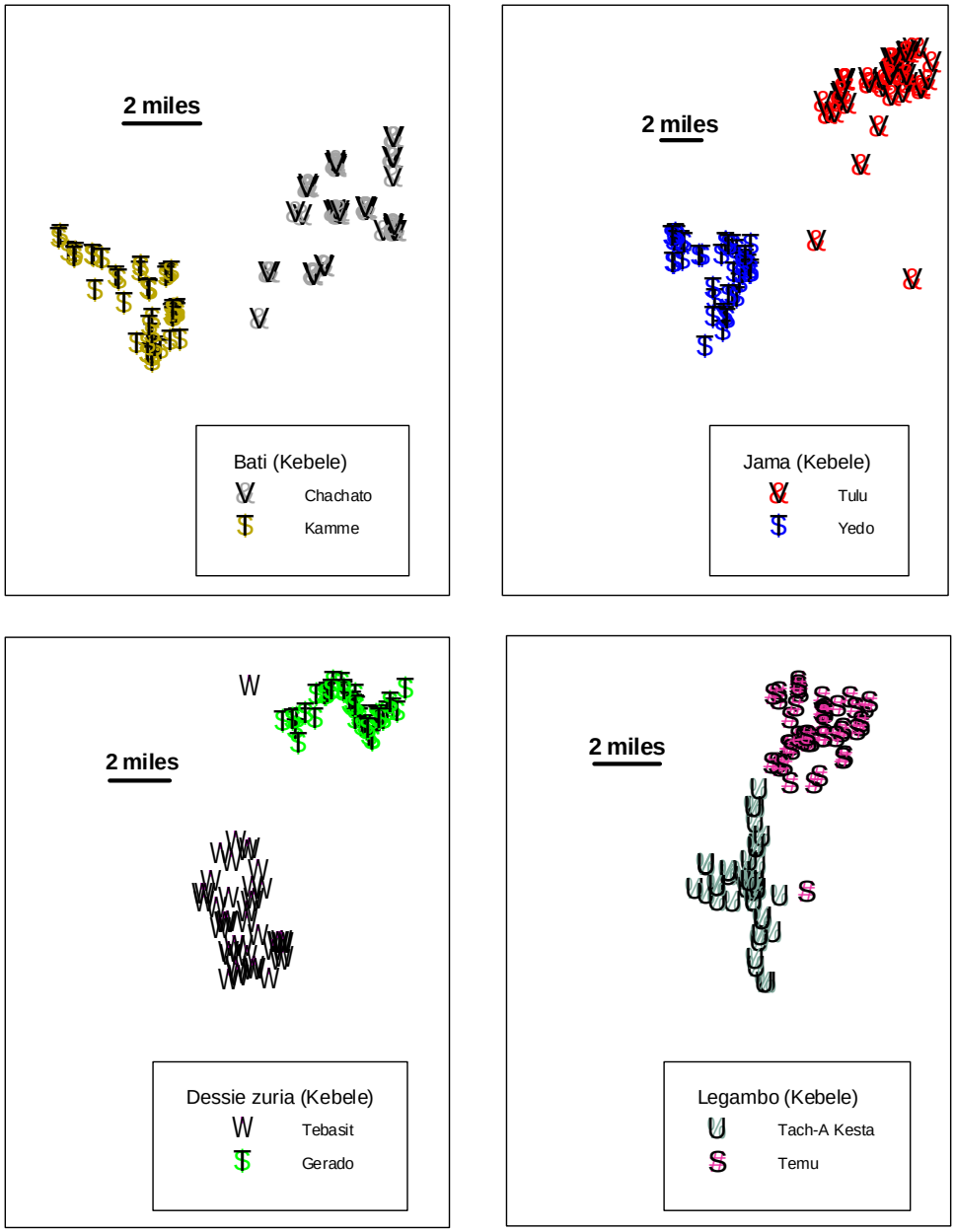

Figure 3. Survey sites by Kebele

Figure 3 plots the relative locations of each survey site within each *woreda* and classifies each site according to *kebele* or peasant association. North is up in all maps and a two-mile scale bar is provided to facilitate the comparison of relative distances between survey sites. Examination of survey locations suggests that some sites may have been classified into incorrect *kebeles.*

II. Local patterns of food security and physical capital

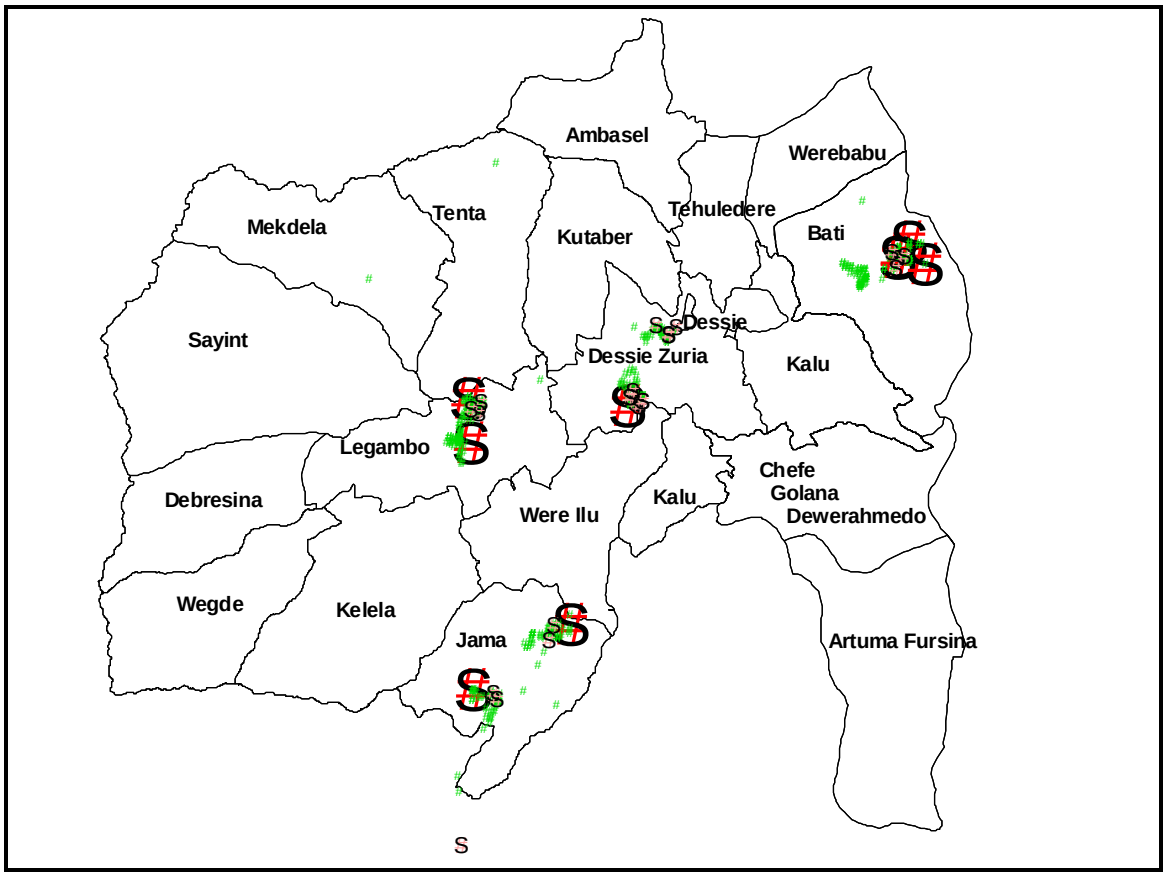

Figure 4. Food security in the South Wello and Oromiya.

Focusing upon the study area, Figure 4 highlights the perceived food security situation of the area in November/December 2001 (i.e., Q13.P1 in the survey data base). Large red circles denote responses of "extremely bad", pink circles represent the response "bad", and green dots represent households that perceive "favorable" or "very favorable" food security situations in the area. At the time of the survey, as indicated in Table 1, the majority of responses were either "favorable" or "very favorable". This situation contrasts markedly with the desperate food security problems that were revealed in 'Round One' data (June 2000) gathered at the end of 1999-2000 drought (Peter Little, personal communication).

	Bati (1)	*Jama (2)*	*Dessie Zuria (3)*	*Legambo (4)*
"Extremely bad"	4	2	1	2
"Bad"	5	5	12	3
"Favorable"	89	87	83	99
"Very favorable"	12	12	5	2

Table 1. Food security in South Wello and Oromiya.

Figure 4 presents a general overview of the food security situation across the entire study area. At this scale of analysis, however, household to household variations in food security are not entirely clear. Focusing upon particular *woredas* and *kebeles* permits the analysis of local variations in food security, and provides an indication of whether or not proximate households or communities tend to perceive and experience similar levels of food security.

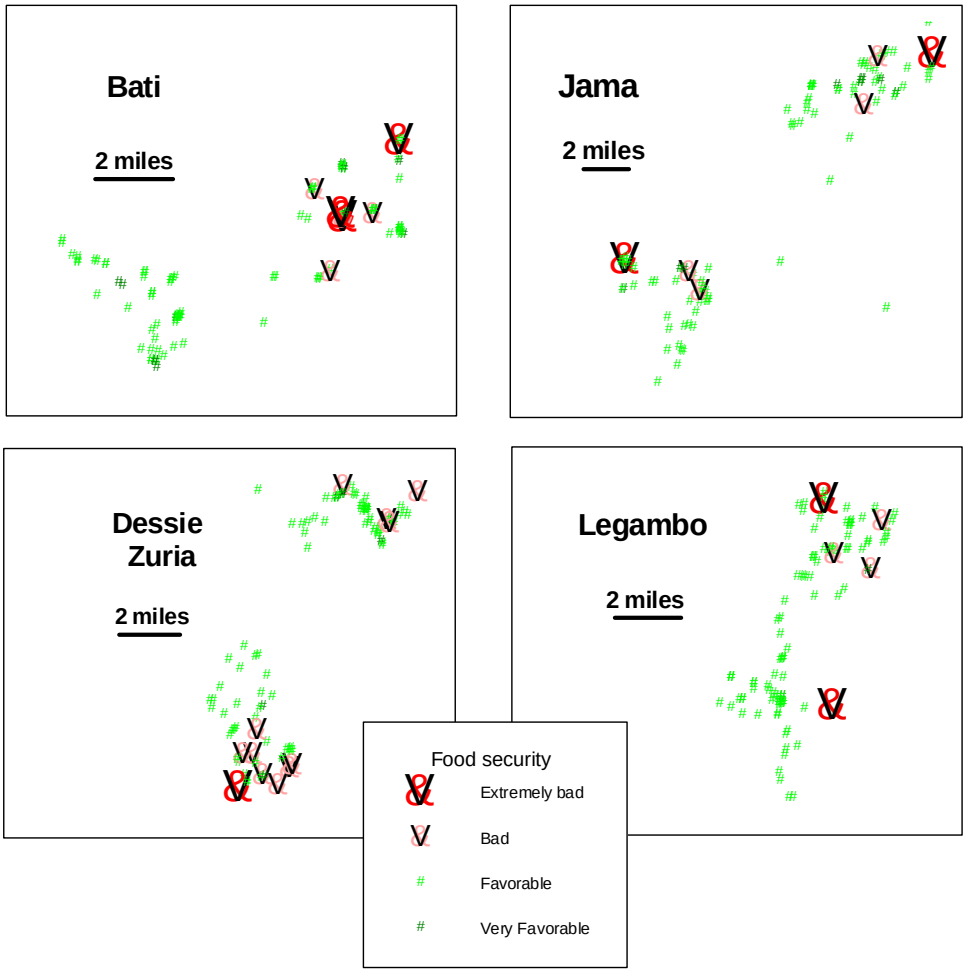

Figure 5. Food security at the local level

Figure 5 presents local maps of perceived food security conditions within each *woreda*. Only the *kebeles* of Kammi (Bati) and Tach-A Kesta (Legambo) reported exclusively "favorable" or better conditions. All other *kebeles* in the study area contained responses of "bad" or "extremely bad". Note that the "extremely bad" case reported in what appears to be Tach-A Kesta (Legambo) is actually coded to be in the *kebele* of Temu (refer to Figure 3). The latitude for this observation is probably incorrect, and it probably should be placed further north, in the Temu cluster of responses. The most prominent cluster of reported food insecurity is located on the southern edge of Tebasit (Dessie Zuria), while the most "extremely bad" responses are situated in Chachato (Bati). These maps illustrate well the local dimensions of food security, and can inform future comparative analyses (e.g., Kamme

v. Chachato in Bati, etc.) of the various social assets that arguably mediate the effects of food security at the community level.

The number of persons affected by food insecurity can also be approximated and visualized for each survey site. Figure 6 plots each household as a circle, the size of which is proportional to the number of household members. Additionally, households that reported either "extremely bad" or "bad" food security conditions are shaded red.

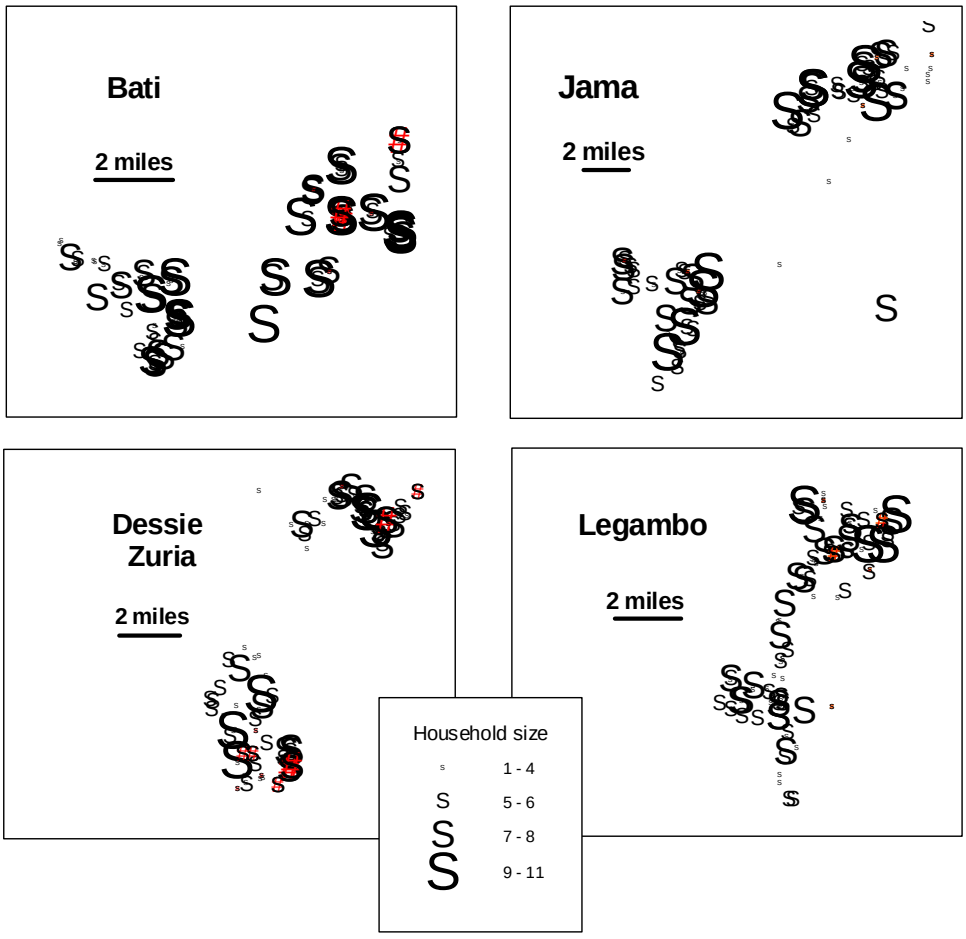

Figure 6. Household size and food security.

It is clear from Figure 6 that surveys were administered across a broad range of household sizes. What is more, "extremely bad" and "bad" food security conditions are not necessarily related to household size. Both relatively small and large households report poor conditions, though at the time of the R4 survey the large majority of responses were "favorable" or better.

One of the general factors associated with food insecurity throughout the study area is access to physical capital. The two measures of physical capital believed to be of central importance in this analysis are access to land and oxen ownership.

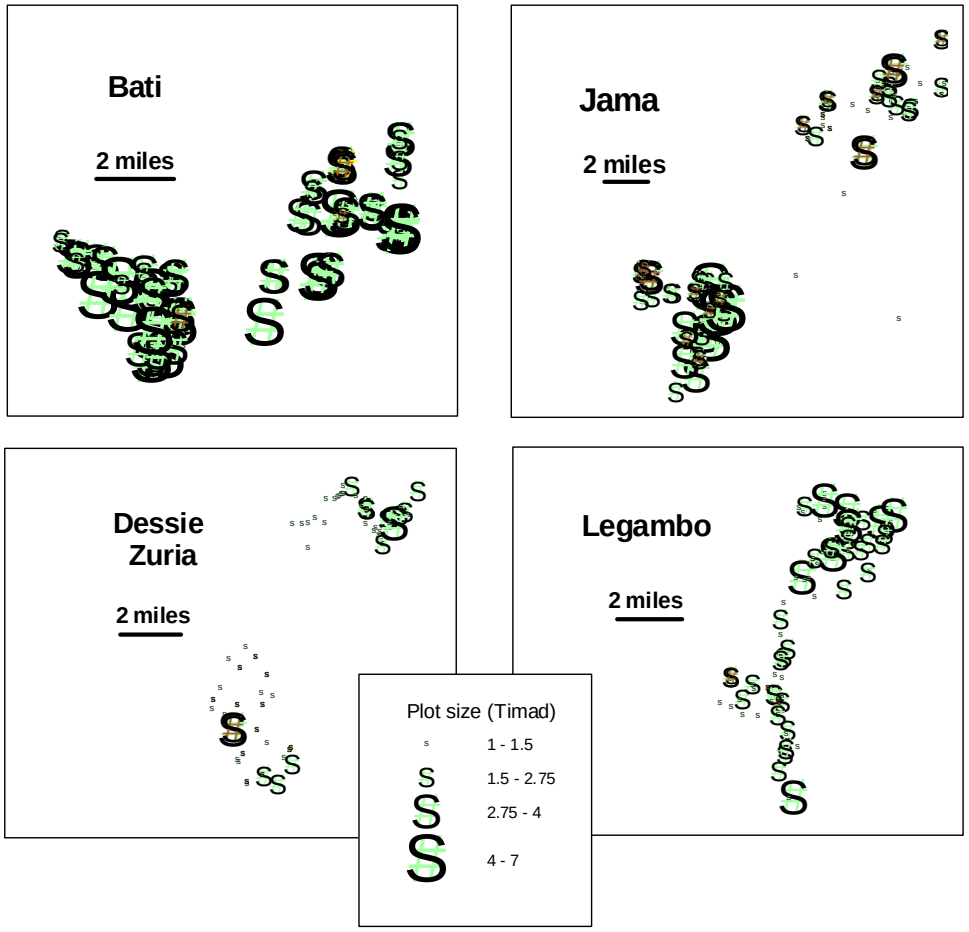

Figure 7. Plot size and soil fertility.

Figure 7 maps the reported size of plots (in Timads) by survey site. Larger circles correspond to larger tracts of land, and those circles shaded brown are reported as "Taf" or infertile land. There is considerable variation in plot size throughout the study area. Respondents in Dessie Zuria have access to the smallest plots, while plots across Bati tend to be considerably larger.

Figure 8 plots ox ownership in each *woreda.* The size of each triangle corresponds to the number of oxen, and respondents who do not own oxen are symbolized with an 'x'. Note that those who do not own oxen may indeed possess other types of livestock such as goats or chickens (refer to Q1.P5 and Q2.P5 in the survey data base).

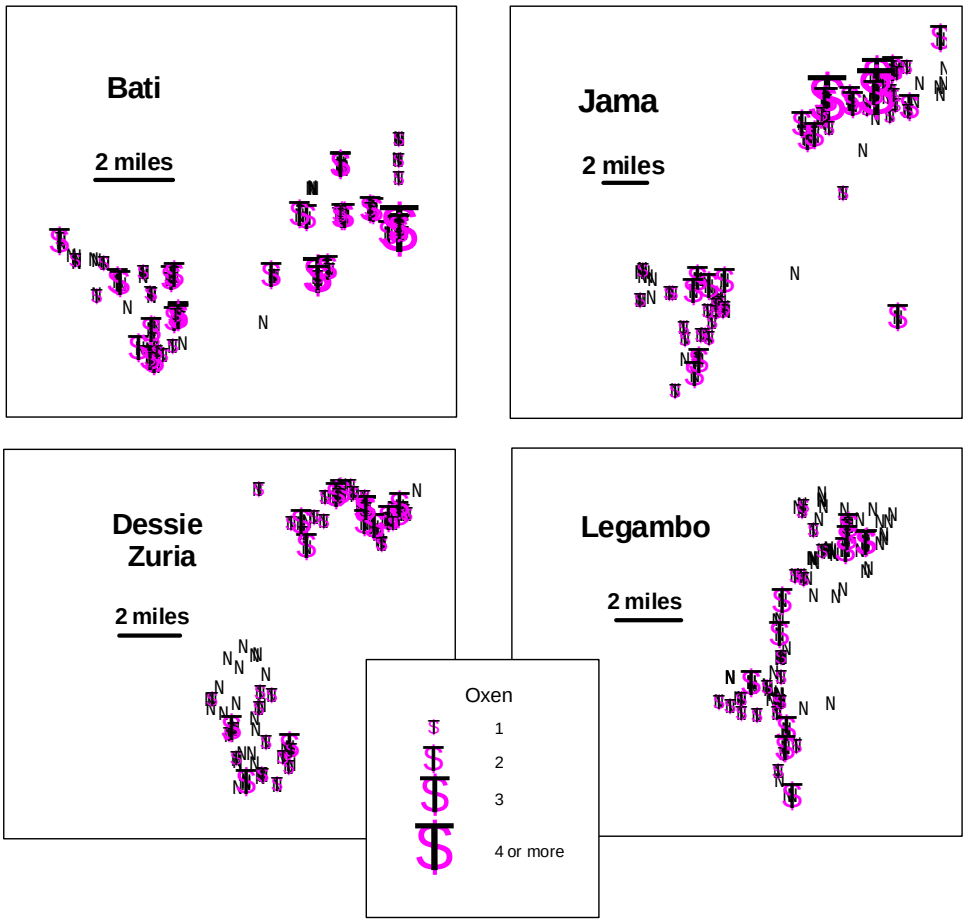

Figure 8. Oxen ownership by survey location.

The geographic distribution of ox ownership does not vary considerably within *kebeles*, though there are some differences. The *kebele* of Tulu (Jama) stands out because several respondents own three or more oxen, while ownership is less prevalent in Tebasit (Dessie Zuria). Complementing this series of maps is Figure 9 that plots the perceived trend in livestock prices from June to November/December 2001.

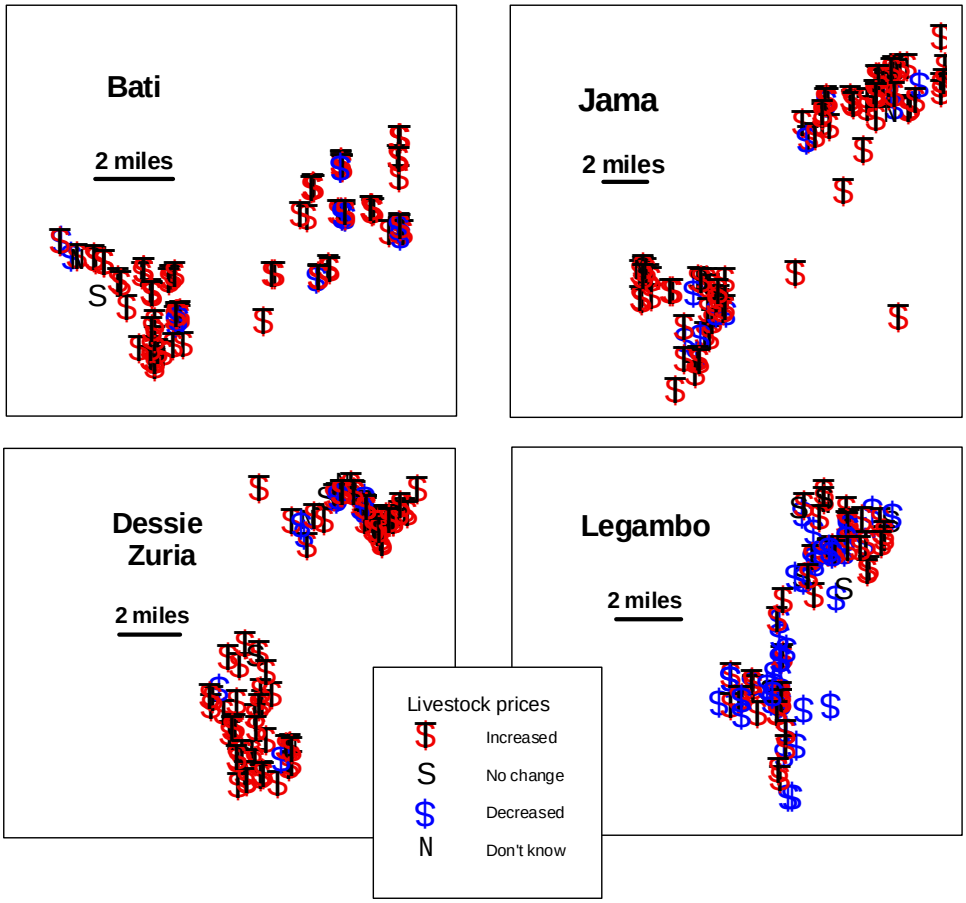

Figure 9. Perceived trends in livestock prices.

Red triangles denote responses of a perceived increase in livestock prices, and inverted blue triangles symbolize a perceived decrease in livestock prices. Note that the question does not disaggregate perceived trends by type of livestock. Nonetheless, an interesting pattern emerges from this final set of maps. The large majority of respondents in the *woredas* of Bati, Jama and Dessie Zuria perceive an upward trend in livestock prices. In Legambo, however, this upward trend is not nearly as widespread. It is interesting to note that such perceptions tend to vary at the scale of the *woreda* and not at the scale of the *kebele.* This pattern probably reflects that fact that respondents in proximate *kebele*, and within the same *woreda*, frequent the same markets, and thus experience identical or similar market trends. These maps suggest, however, that such market trends vary across the study area, perhaps by *woreda.*

III. Conclusion

This preliminary analysis of the R4 survey data illustrates clearly the utility of integrating GIS and GPS technologies into the scope of the BASIS research program, and into food security research in general. The coupling of GIS and GPS can be used to verify and check data, but its greatest contribution lies in its data visualization capabilities. Placing R4 survey responses in geographic context not only informs current research questions and hypotheses, but it can facilitate the formulation and articulation of research questions concerning food security in the future. Efforts need to be made to determine which variables possess a geographic component, and which research questions can benefit most from implementing geographic information technologies. Using GIS and GPS to situate survey responses into a precise spatial context is an innovative and underutilized research technique that can shed light upon the geographic contingencies and processes that underlie food security in South Wello and Oromiya.