

Towards the Smart Farm

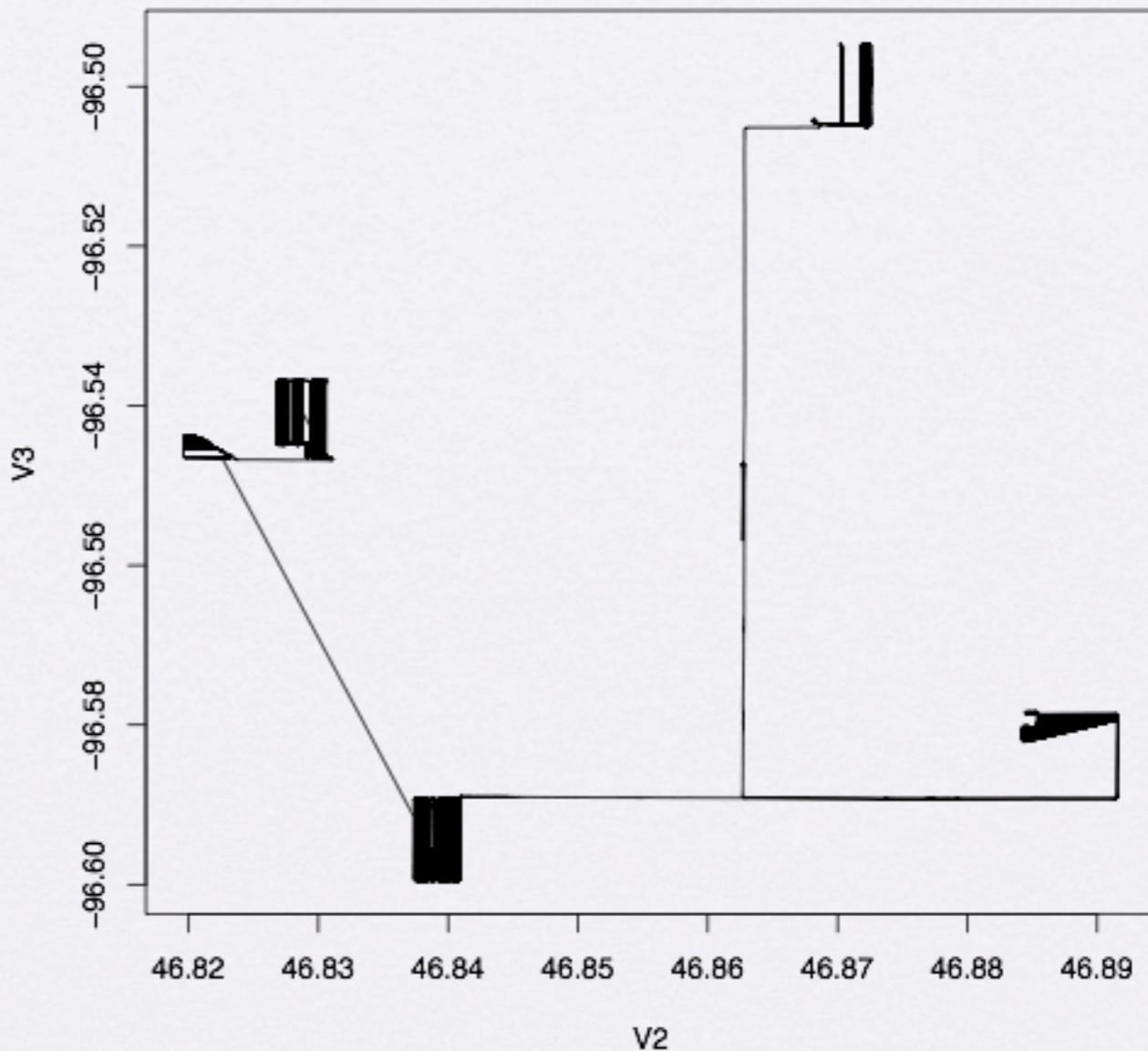
Anne Denton, Saeed Salem,
and Dean Knudson

Consortium Year 1

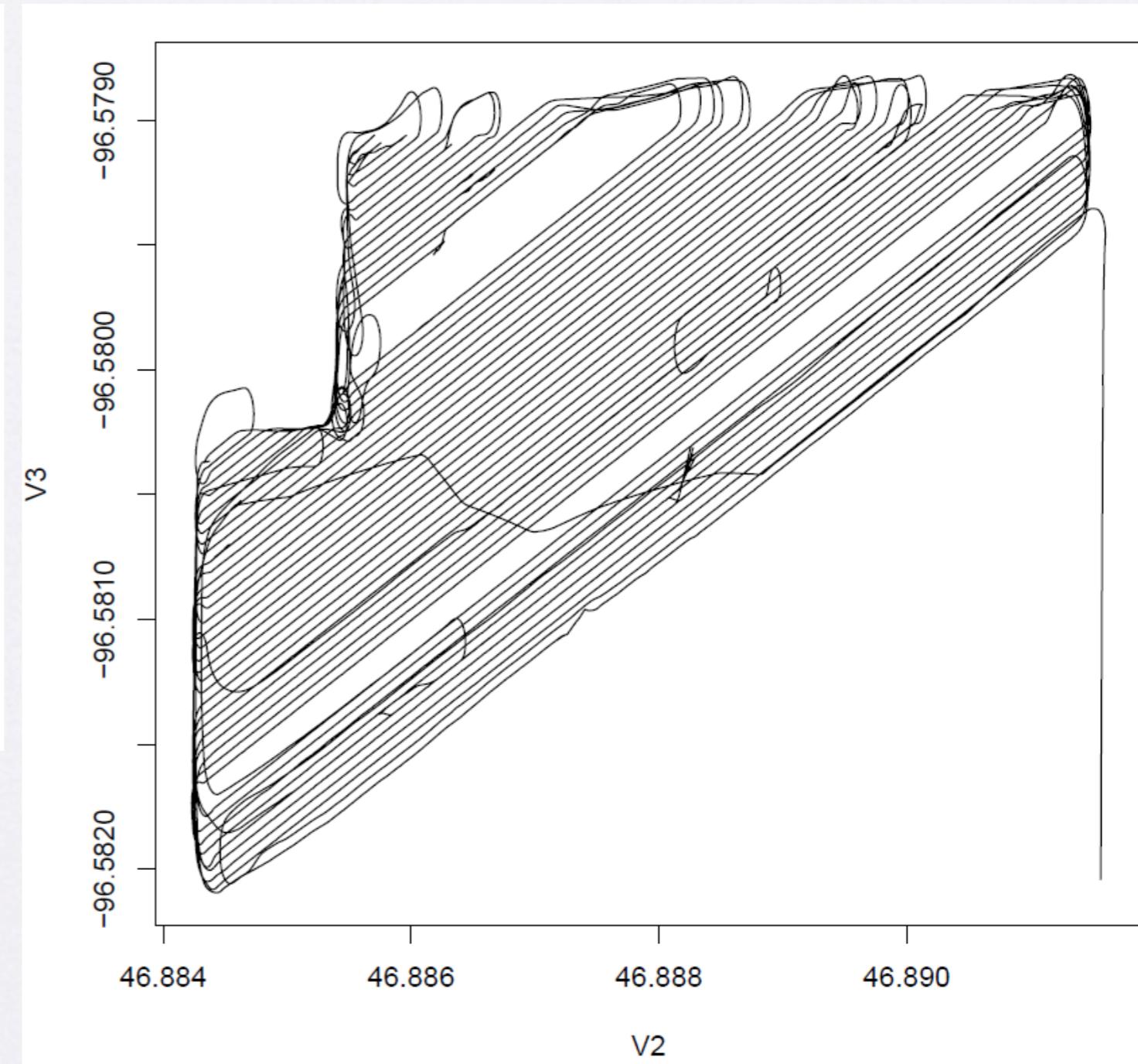
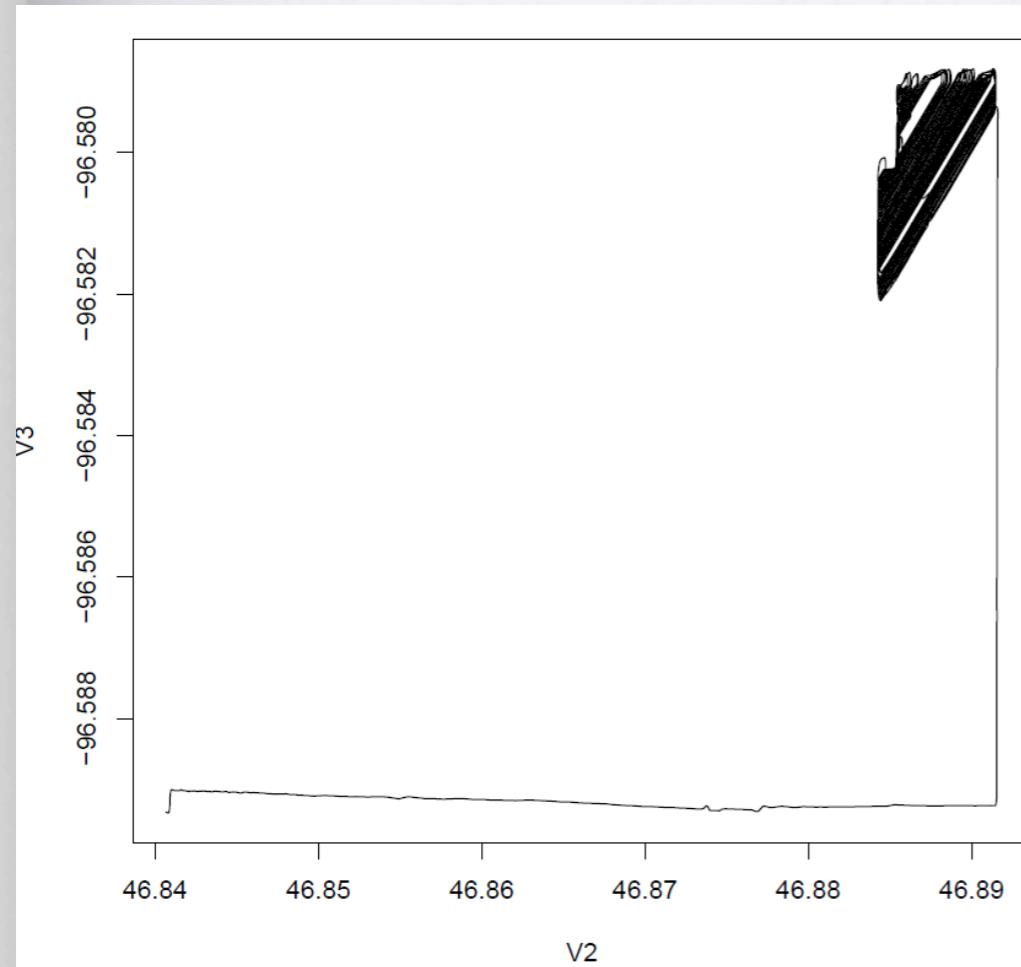
- Extract yield data
 - Identify areas and relate to dump site data
 - Export in GIS Shape File format
- Small-granularity yield data for further analysis
- Yield prediction (Saeed)
- Feature analysis (Anne)

Combined Beet Lifter Data

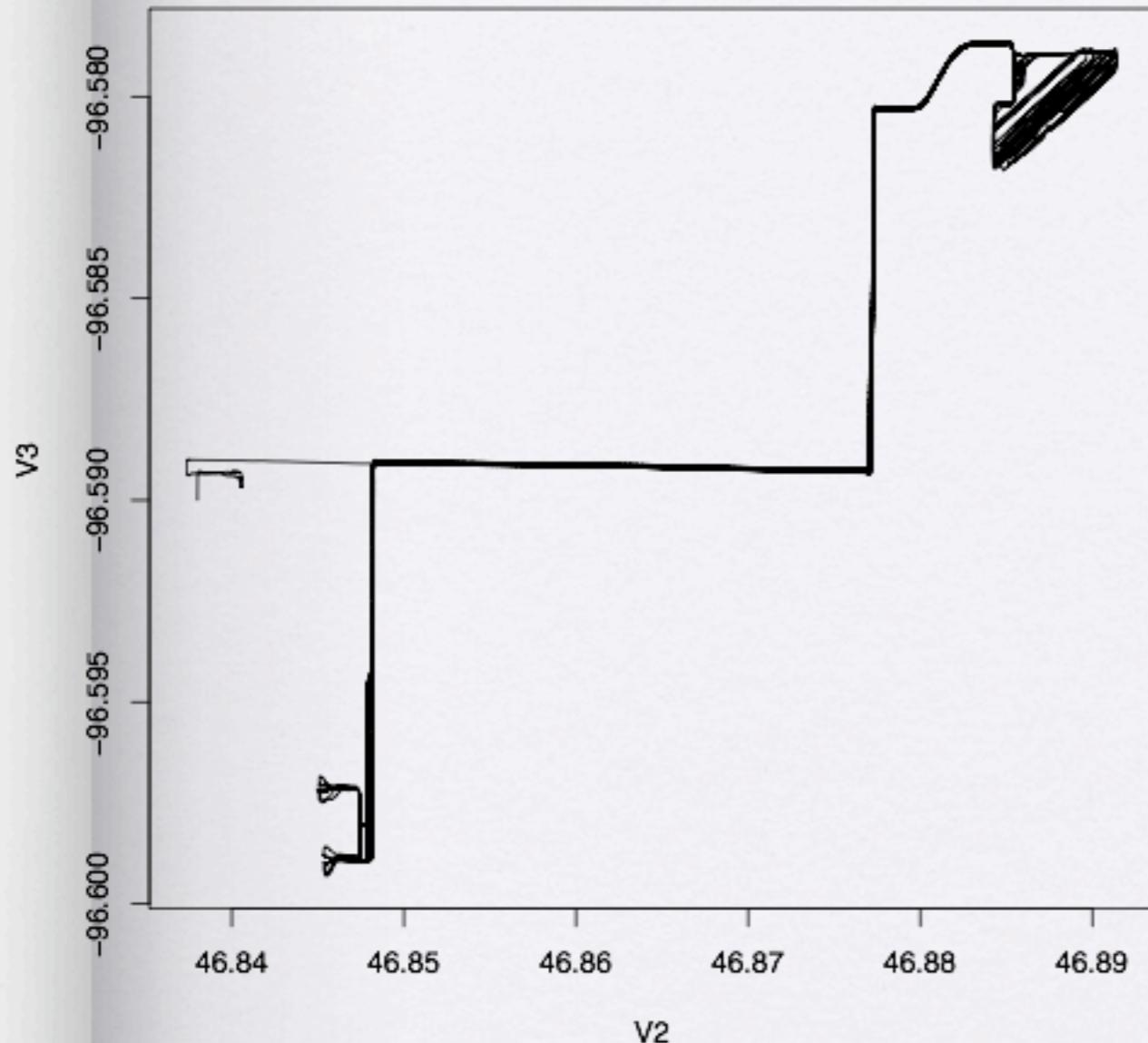
- All Lifter data
- Notice multiple fields



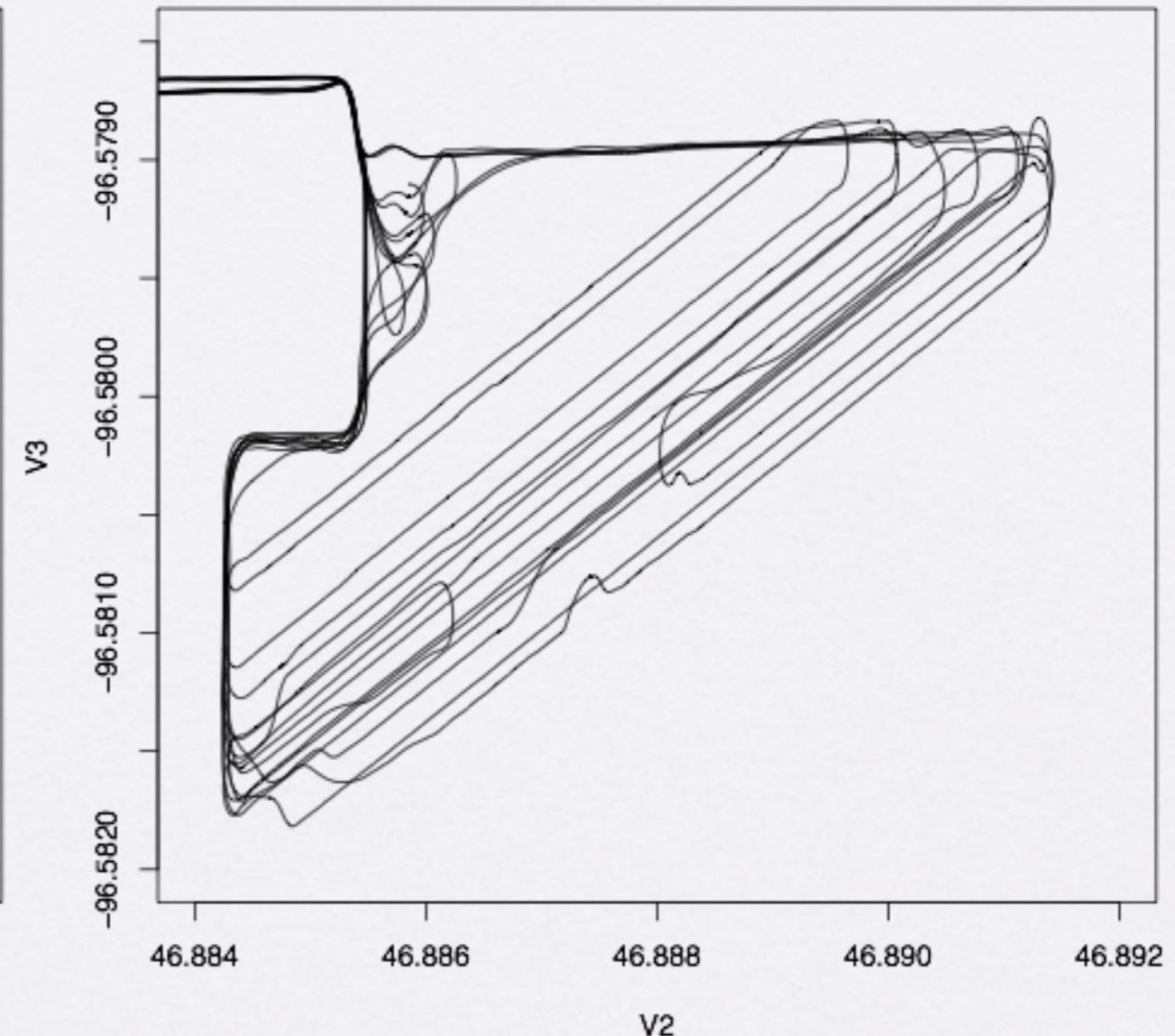
One Field Beet Lifter Data



Truck Data

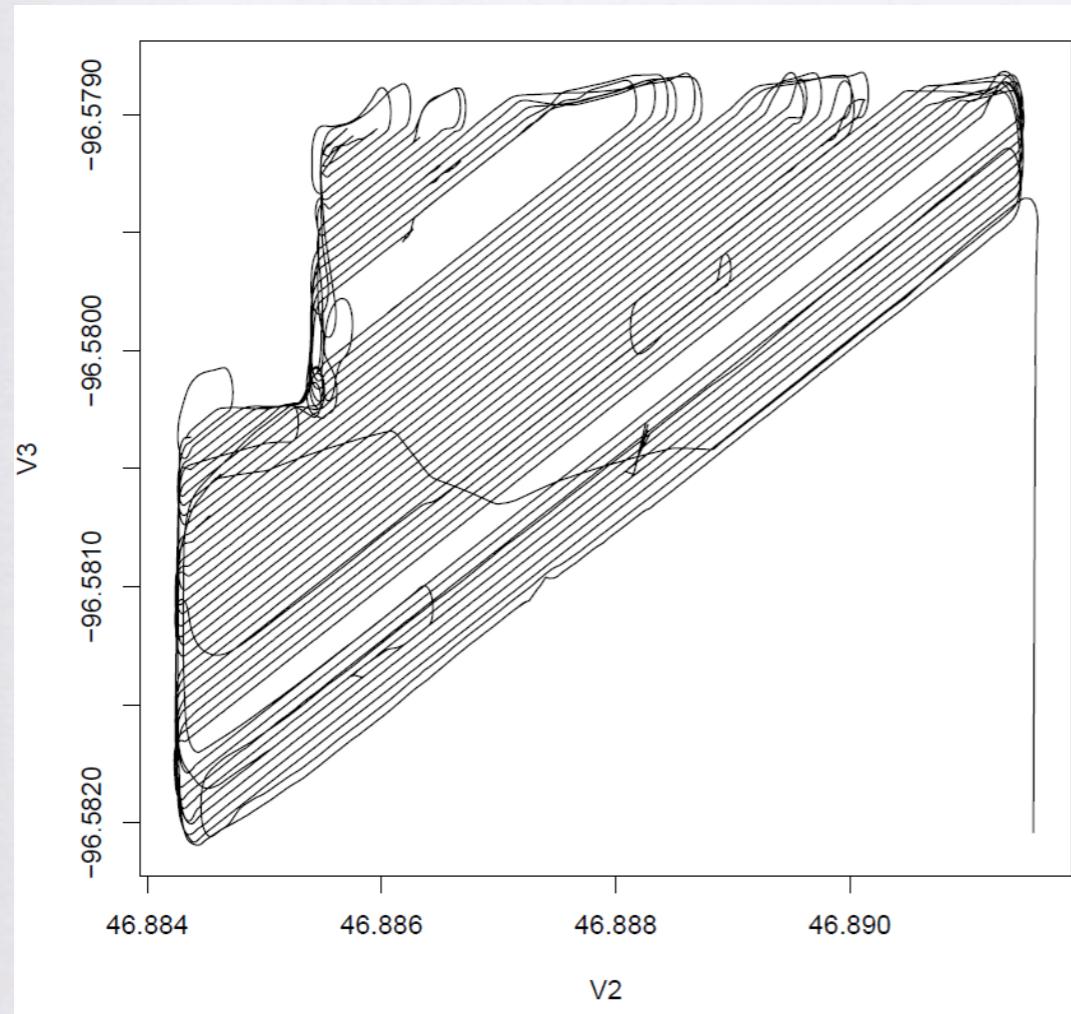


- Combined data of truck during one shift.

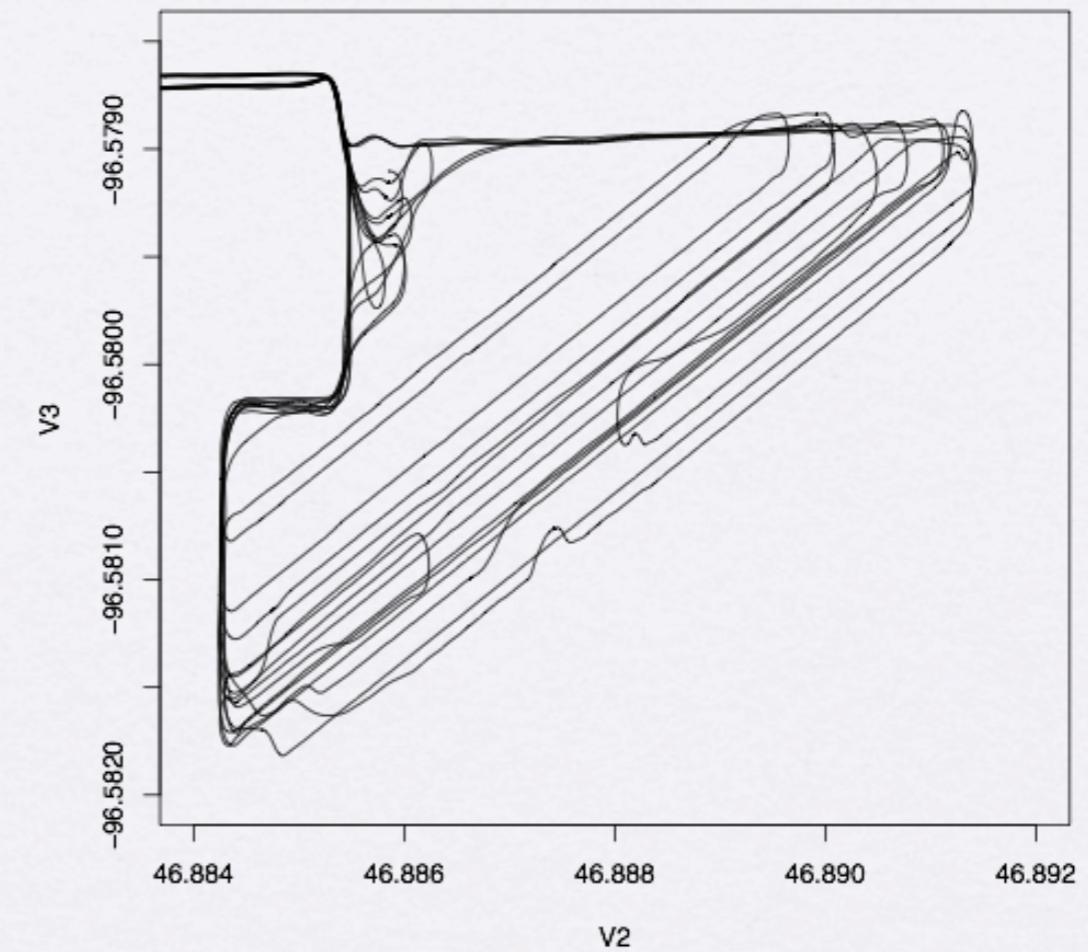


- Cleaned version of image on the left with only data points in field.

Relate Areas to Truck Loads



Lifter



Truck

- Find paths for which trucks are within specified distance of lifter

Where the beets are coming from?

GMTdate 20101007 Client 100003 Farm 5 Field 8 2010 Beet

Close : from 06:57:44 (46.8881573 , -96.5802988) to 07:12:38 (46.8868652 , -96.5806653)
06:57:44,46.8881573,-96.5802988,46.8875583,-96.5804518,11.626983634464196
06:58:44,46.8889761,-96.5799804,46.8888136,-96.5799604,1.5198439398393437

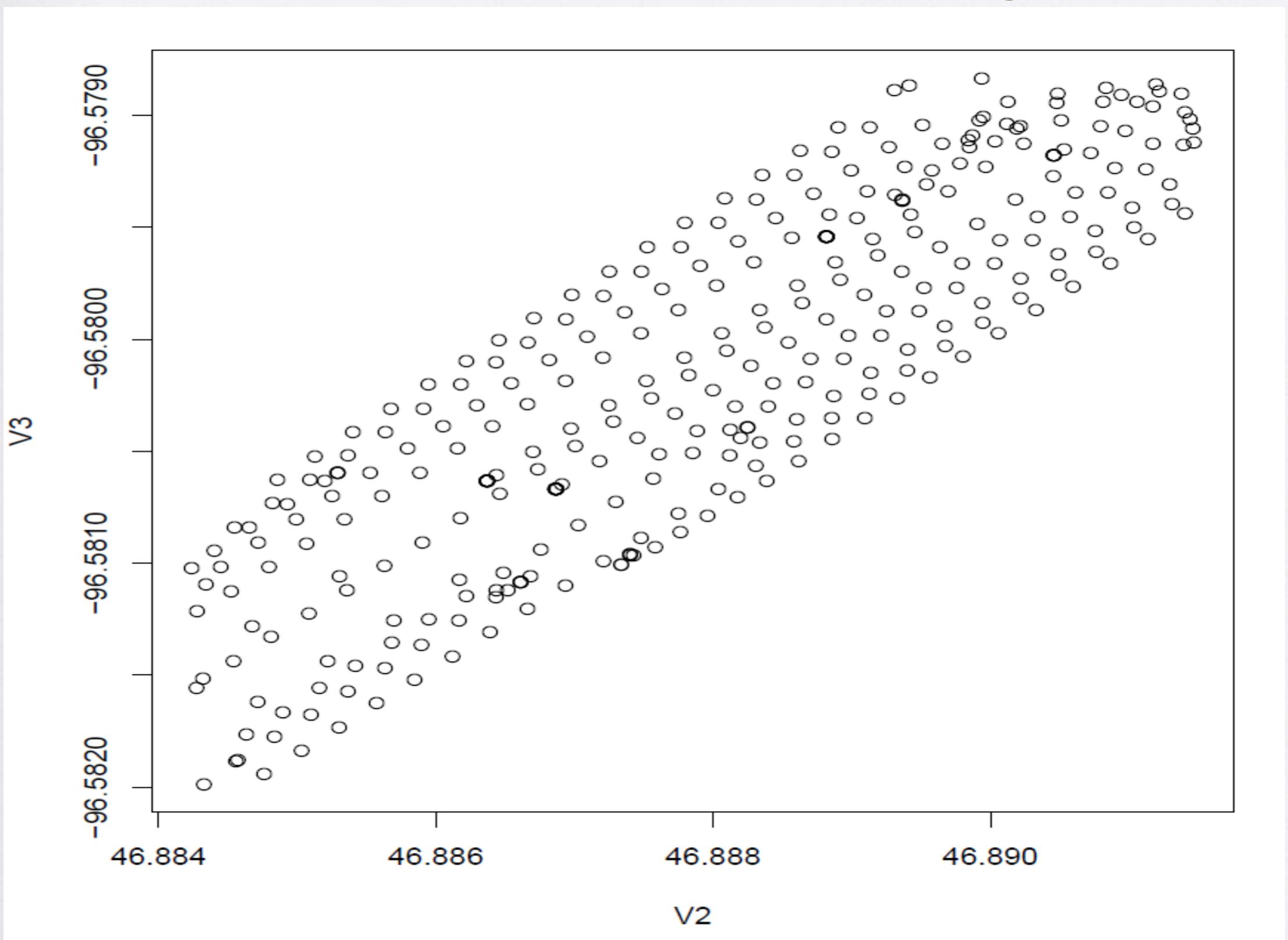
.....

Close : from 07:51:38 (46.8846345 , -96.5817616) to 08:03:13 (46.8904566 , -96.5791768)
07:51:38,46.8846345,-96.5817616,46.8845356,-96.5817057,4.2483076473151531
07:52:38,46.8854197,-96.5814546,46.8853867,-96.5813807,5.6161957069949322

.....

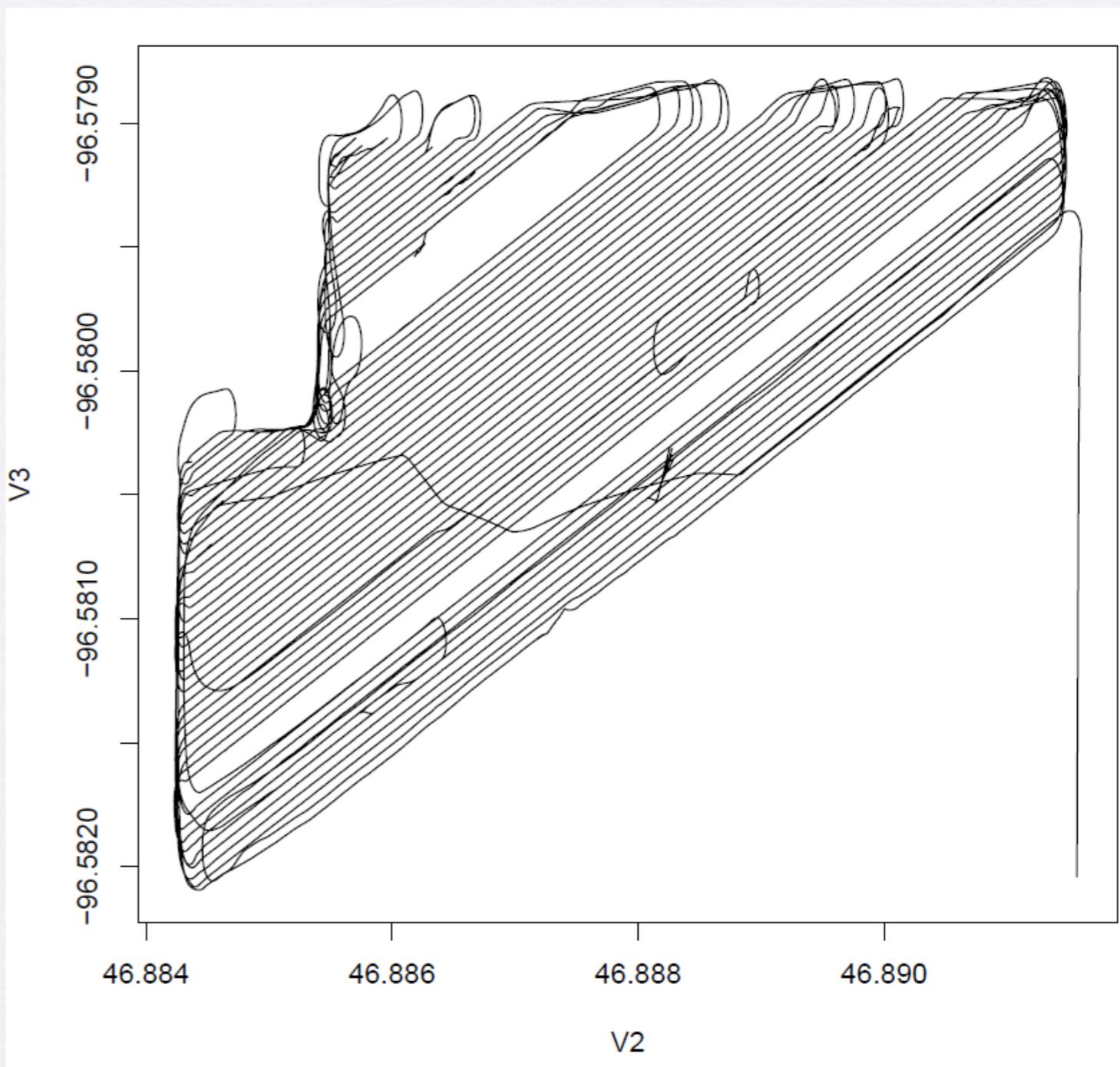
6 More Loads.

Where the beets are coming from?



Possible Further Processing

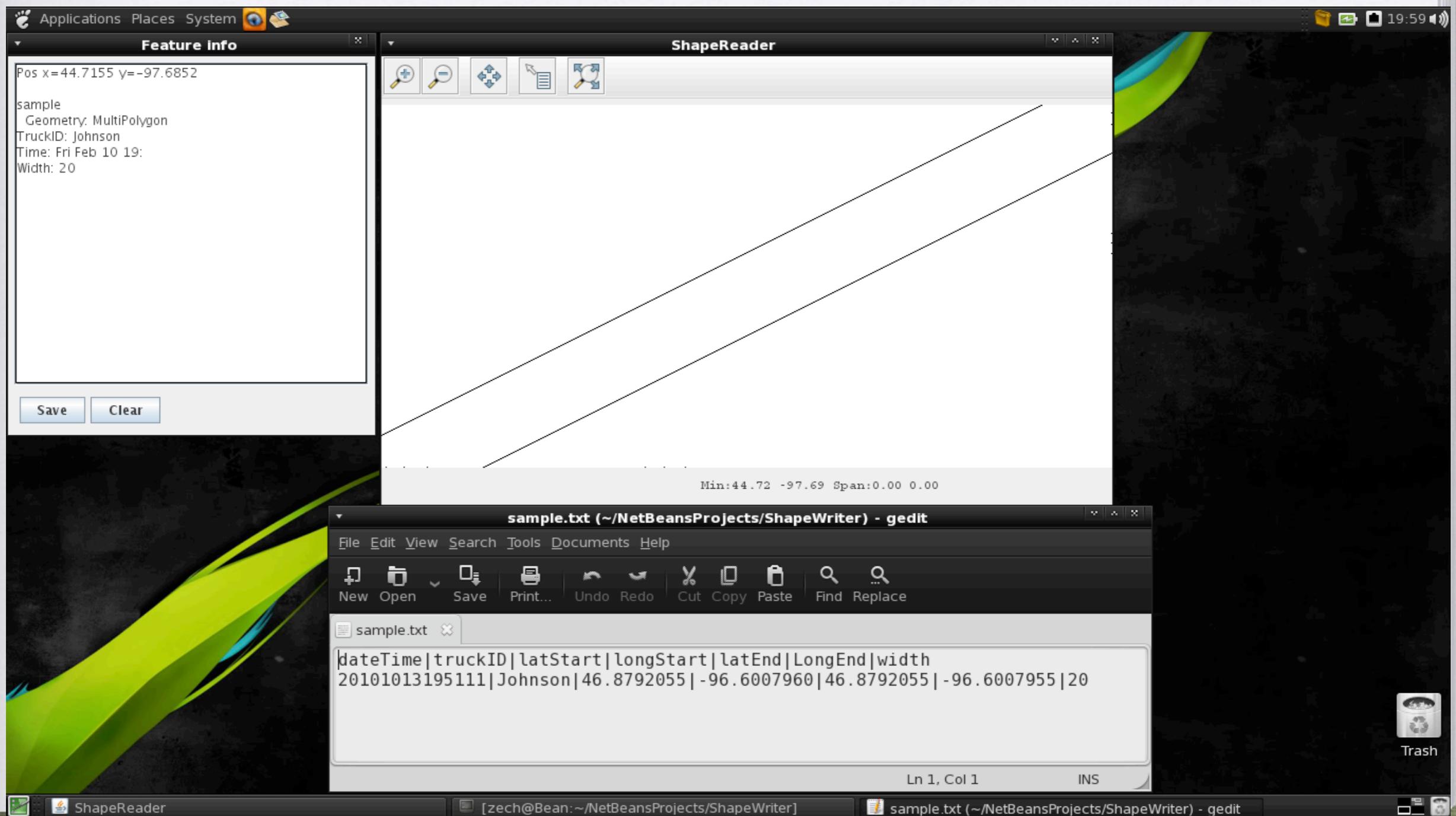
- Determine straight sections of tractor routes



Export in GIS Shape File Format

- Allows easy integration for AgrilmaGIS
- Standard format for Geographic Information Systems
- Can be written out from a program in Java programming language (... we are pretty sure of this but it doesn't work yet ...)
- (Current status: The file from the Shape File writer can be read in by the same interface but not by ArcGIS)

Current Status for Shape FileWriter

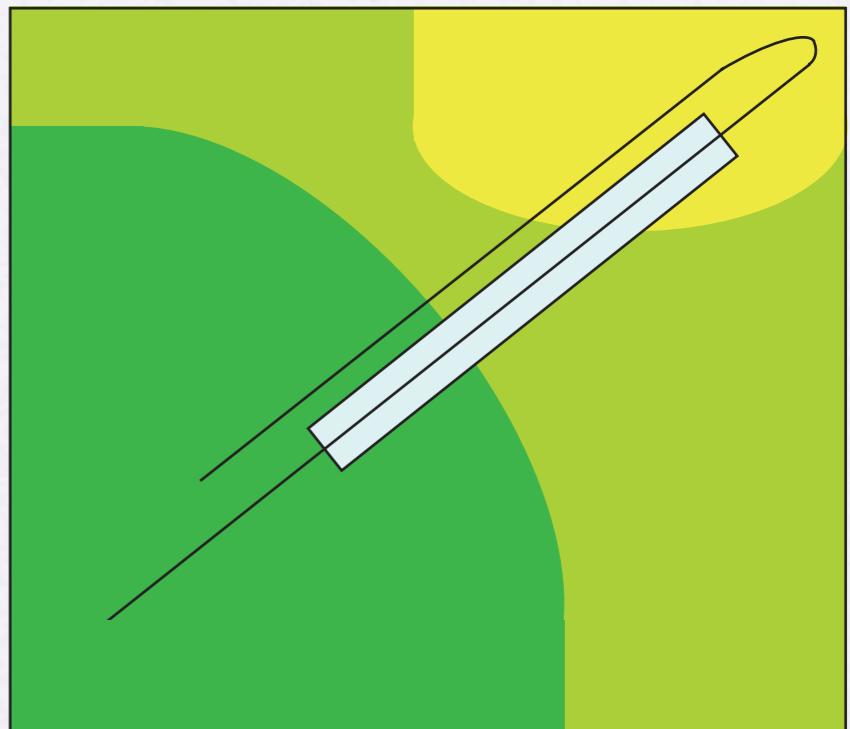


Small-granularity Yield Data

- Standard data sets, derived using yield monitors, have yield information available at pixel level
- Extraction based on truck loads gives information for elongated regions
- Regions may span areas with very different characteristics
- Goal:
 - Model for yield data at pixel level

Production Zones for Pixel-level Yield

- Truck loads likely span multiple in-field production zones (as derived by AgrilmaGIS)
 - Try to build model for relating production zone information to yield (attributing maps with yield data)
 - Ideally check against yield monitor on lifter



Relating Yield to Production Zones

- Problem is specific to yield measurement based on trucks (rather than instrumented tractors)
 - Can be done by assuming constant yield per production zone (system of linear equations)
 - Could also be done by building a model based on color, e.g. assume dependence of yield on color
- Necessary as processing step in developing a data set for further analysis

Extension to Field-level Data

- Models that relate yield to production zones could also be tested at the level of fields
- Benefit:
 - Data available for more years
- Drawback:
 - Lighting conditions unlikely to be consistent
- If it hasn't worked so far, why try again?
 - Experience with truck-level data may help

Develop Data Set for Advanced Analysis

- Derive estimated yield at the pixel level from previous step
- Collect images from multiple years
- Collect additional information from farmers
 - Which variety was planted
 - Information on pesticides / fertilizer /water
 - Information on diseases / hail damage

Timescale of Advanced Analysis

- Building relationship with farmers will take time
- Get results in first year on easy to obtain data
 - (Maybe) easiest additional data to collect is crop of previous years
 - (Unfortunately, NDSU-collected land-use data ends 2003)
 - Also (maybe) weather farmer has applied chemicals based on production zone information

Prediction

- In machine learning, prediction is based on multiple attributes
- Go beyond current color information alone by using additional information
- Different features in the full data set will be evaluated for their benefit in prediction

Feature Analysis

- Farmers want to know
 - What the yield will be ...
 - **and** how different treatments will change yield
- Possible questions
 - How does the crop that was planted during the previous year affect yield / color?
 - How do fields that have been fertilized based on production zones differ from others?

Feature Analysis

- Could be extended to include
 - Any information available from the farmer
 - Weather information
- Impact of features can be evaluated based full color information
 - Previous work on using complex information for determining feature importance available (Anne)
 - Has been successful in chemistry of coatings, microbiology stock market analysis ...

Deliverables Year 1

- Shape Files with yield data for each area (Anne and Saeed)
- Small-granularity yield data through model for relationship between AgrilmaGIS production zones and yield data (Anne)
- Prediction model for yield from image data directly (Saeed)
- Relationship of yield to some other feature such as the crop of the previous year (Anne)

Wish List

- AgrilmaGIS production zones
- Previous year images and production zones (AgrilmaGIS)
- Previous year yield data (ACS)
- Data from yield monitors on lifters
- Treatment information
 - Were production zones used in application of fertilizer?
 - Seed / fertilizer / pesticide / etc. information