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Cropland Classification Accuracy as a Function of Training Data Accuracy

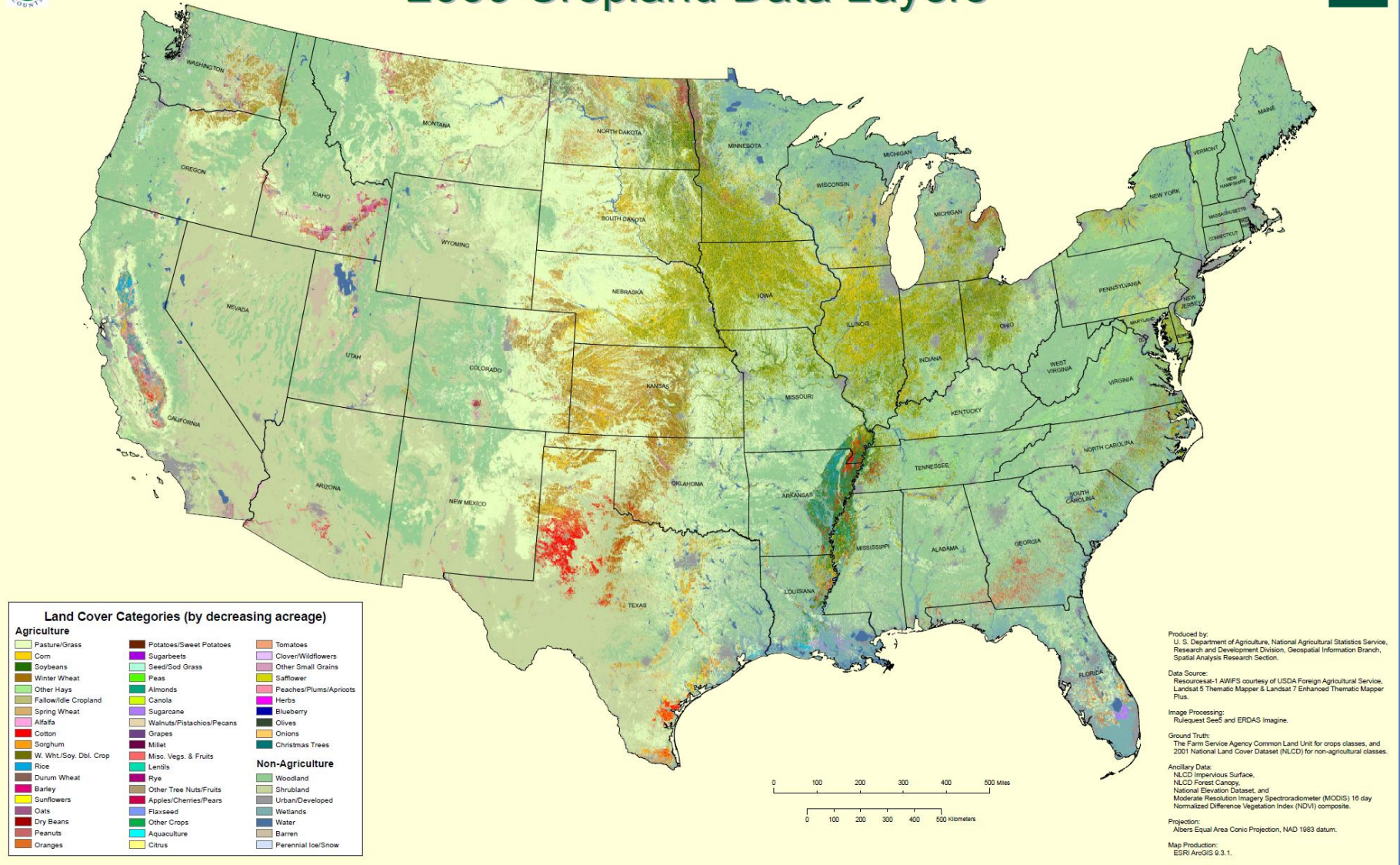
Association of American Geographers, 2010 Annual Meeting



Study Overview

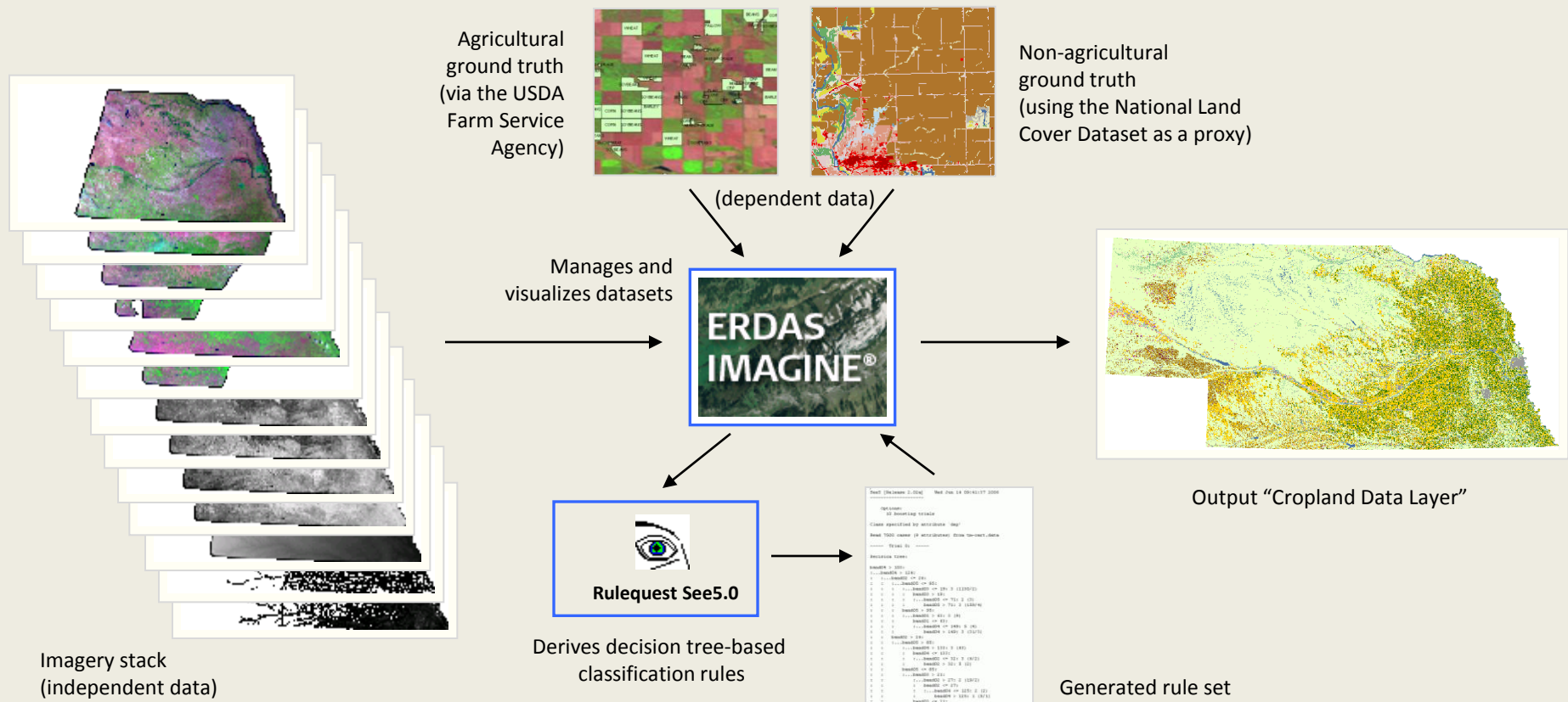
- Want to understand how potential errors in training data impact decision-tree based land cover classification
 - Especially tailored to mapping efforts within NASS
 - Primarily in regions dominated by common commodity crops
- Hypothesis : Classification accuracy decreases as training data accuracy decreases
 - By how much?
 - Is there a threshold?
 - What's the relationship?
 - Is it linear?
 - Are there scenarios where it improves the outcome?
- Chose 3 states to test these questions
 - Iowa
 - Idaho
 - North Dakota

2009 Cropland Data Layers

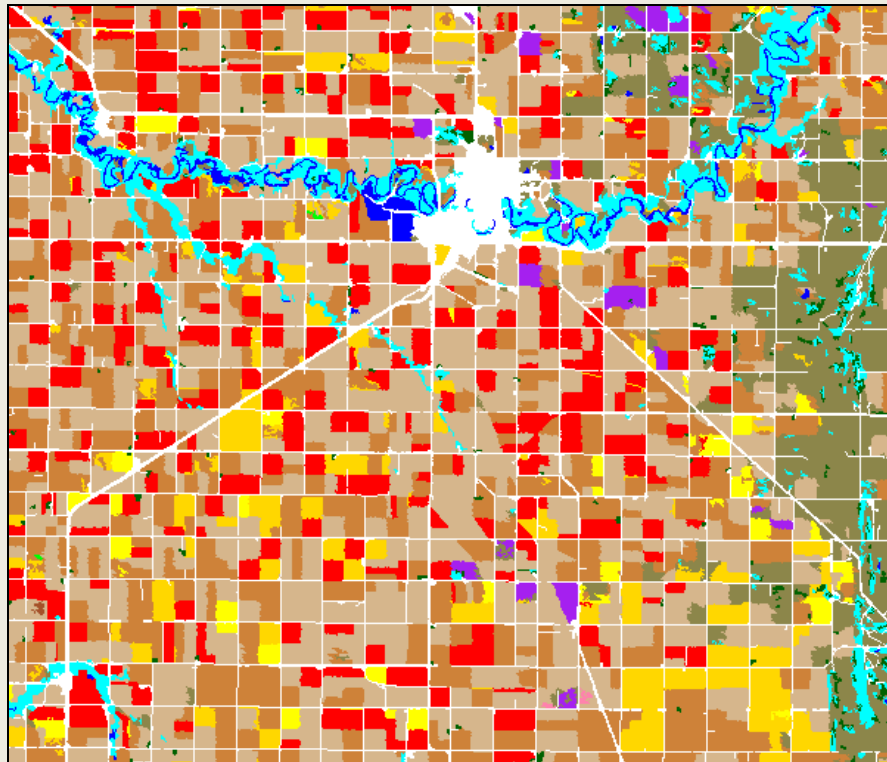


Classification Methodology Overview

- 1) “Stack” AWiFS, TM, MODIS, and ancillary data layers within a raster GIS
 - 56 m grid cells, Albers Conic Equal Area projection, common extent by state
 - some compromised imagery (from clouds, haze, data gaps, etc.) is acceptable
- 2) Sample spatially from stack within known ground truth from FSA (ag. categories) and NLCD (non-ag. categories)
 - a heavy sample rate (100s of thousands) at the pixel level is employed
- 3) “Data-mine” samples using Boosted Classification Tree Analysis to derive best fitting decision rules
 - implemented with Rulequest See5.0, interfaced with ERDAS Imagine with the “NLCD Mapping Tool”
- 4) Create land cover map by applying derived decision rules back to input data stack



Example Classification Subset



CDL Classification

(red = sugar beets, brown = soybeans
tan = spring wheat, gold = corn,
yellow = sunflowers)

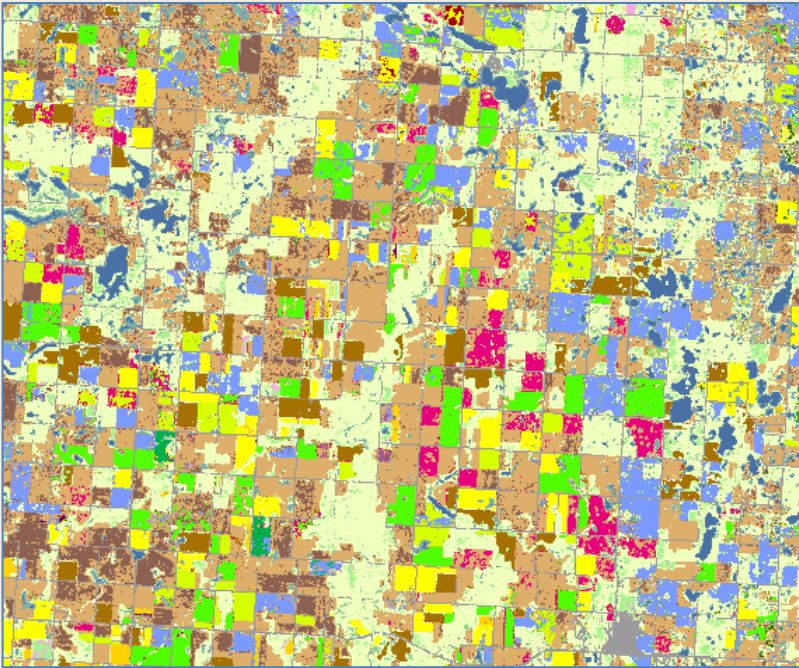


Resourcesat-1 AWiFS, 6 July 2007

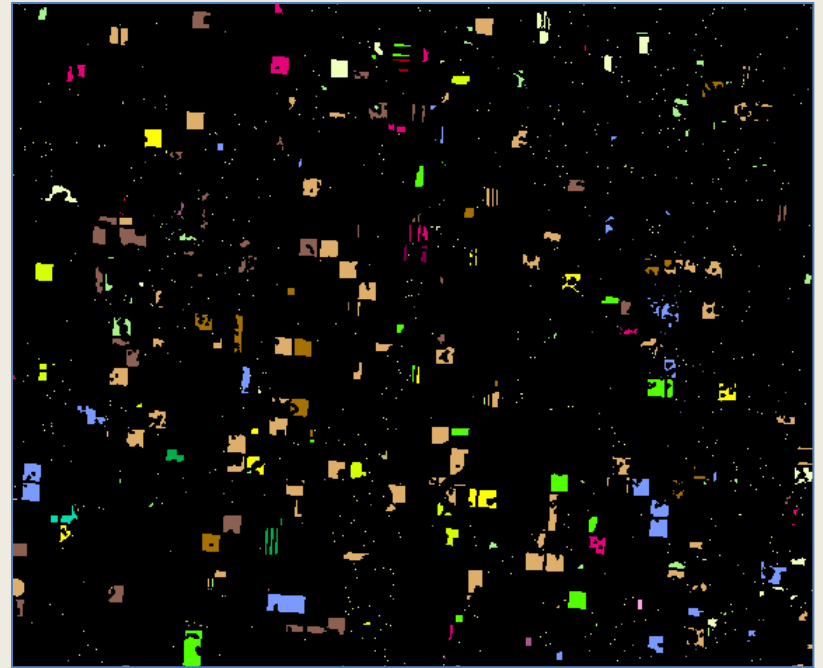
(red =SWIR band,
green=NIR band,
blue=red band)

Accuracy Assessment

Each classification tested against independent set of ground truth data to determine overall and within class accuracies



Example classification subset



Example validation subset

Degradation methodology

Altered sample files with
X'th row scrambled

Column with land cover
category value

DG	DH	DI	DJ	DK	DL	DM	DN
133	22	3474	8460	434	0	0	1
132	21	3474	8460	436	0	0	1
133	24	4020	9158	435	0	0	1
138	24	2939	9249	440	0	0	1
133	20	3711	9183	439	0	0	1
134	22	3711	9183	439	0	0	1
133	23	3324	9359	437	0	0	1
134	30	4205	9011	440	0	0	1
140	28	3759	9042	438	0	0	1
134	25	3770	9252	436	0	0	1
135	24	2864	9244	439	0	0	1
132	23	3324	9359	437	0	0	1
134	24	3759	9042	437	0	0	1
134	23	4205	9011	438	0	0	1
134	24	3433	9104	435	0	0	1
134	23	3372	8987	439	0	0	1
133	23	3372	8987	440	0	0	1
134	22	3685	8875	438	0	0	1

Original sample file
with no known errors
(dozens of columns,
hundreds of thousands
of rows in reality)

Every
row

DG	DH	DI	DJ	DK	DL	DM	DN
133	22	3474	8460	434	0	0	1
132	21	3474	8460	436	0	0	5
133	24	4020	9158	435	0	0	181
138	24	2939	9249	440	0	0	1
133	20	3711	9183	439	0	0	5
134	22	3711	9183	439	0	0	1
133	23	3324	9359	437	0	0	1
134	30	4205	9011	440	0	0	1
140	28	3759	9042	438	0	0	1
134	25	3770	9252	436	0	0	5
135	24	2864	9244	439	0	0	1
132	23	3324	9359	437	0	0	5
134	24	3759	9042	437	0	0	1
134	23	4205	9011	438	0	0	1
134	24	3433	9104	435	0	0	1
134	23	3372	8987	439	0	0	1
133	23	3372	8987	440	0	0	5
134	22	3685	8875	438	0	0	181

Every
other
row

DG	DH	DI	DJ	DK	DL	DM	DN
133	22	3474	8460	434	0	0	1
132	21	3474	8460	436	0	0	5
133	24	4020	9158	435	0	0	1
138	24	2939	9249	440	0	0	1
133	20	3711	9183	439	0	0	1
134	22	3711	9183	439	0	0	1
133	23	3324	9359	437	0	0	1
134	30	4205	9011	440	0	0	1
140	28	3759	9042	438	0	0	1
134	25	3770	9252	436	0	0	5
135	24	2864	9244	439	0	0	1
132	23	3324	9359	437	0	0	5
134	24	3759	9042	437	0	0	1
134	23	4205	9011	438	0	0	1
134	24	3433	9104	435	0	0	1
134	23	3372	8987	439	0	0	1
133	23	3372	8987	440	0	0	1
134	22	3685	8875	438	0	0	181

Every
third
row

DG	DH	DI	DJ	DK	DL	DM	DN
133	22	3474	8460	434	0	0	1
132	21	3474	8460	436	0	0	1
133	24	4020	9158	435	0	0	181
138	24	2939	9249	440	0	0	1
133	20	3711	9183	439	0	0	1
134	22	3711	9183	439	0	0	1
133	23	3324	9359	437	0	0	1
134	30	4205	9011	440	0	0	1
140	28	3759	9042	438	0	0	1
134	25	3770	9252	436	0	0	1
135	24	2864	9244	439	0	0	1
132	23	3324	9359	437	0	0	5
134	24	3759	9042	437	0	0	1
134	23	4205	9011	438	0	0	1
134	24	3433	9104	435	0	0	1
134	23	3372	8987	439	0	0	1
133	23	3372	8987	440	0	0	1
134	22	3685	8875	438	0	0	181

Etc.

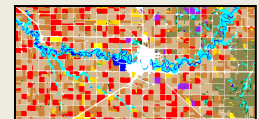
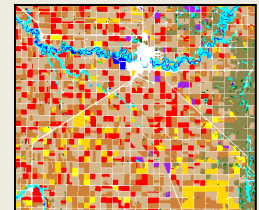
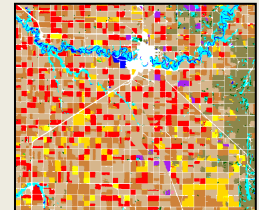
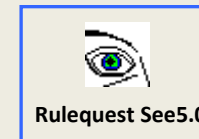
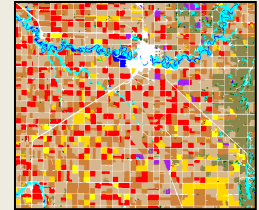
Every
forth
row

DG	DH	DI	DJ	DK	DL	DM	DN
133	22	3474	8460	434	0	0	1
132	21	3474	8460	436	0	0	5
133	24	4020	9158	435	0	0	1
138	24	2939	9249	440	0	0	1
133	20	3711	9183	439	0	0	1
134	22	3711	9183	439	0	0	1
133	23	3324	9359	437	0	0	1
134	30	4205	9011	440	0	0	1
140	28	3759	9042	438	0	0	1

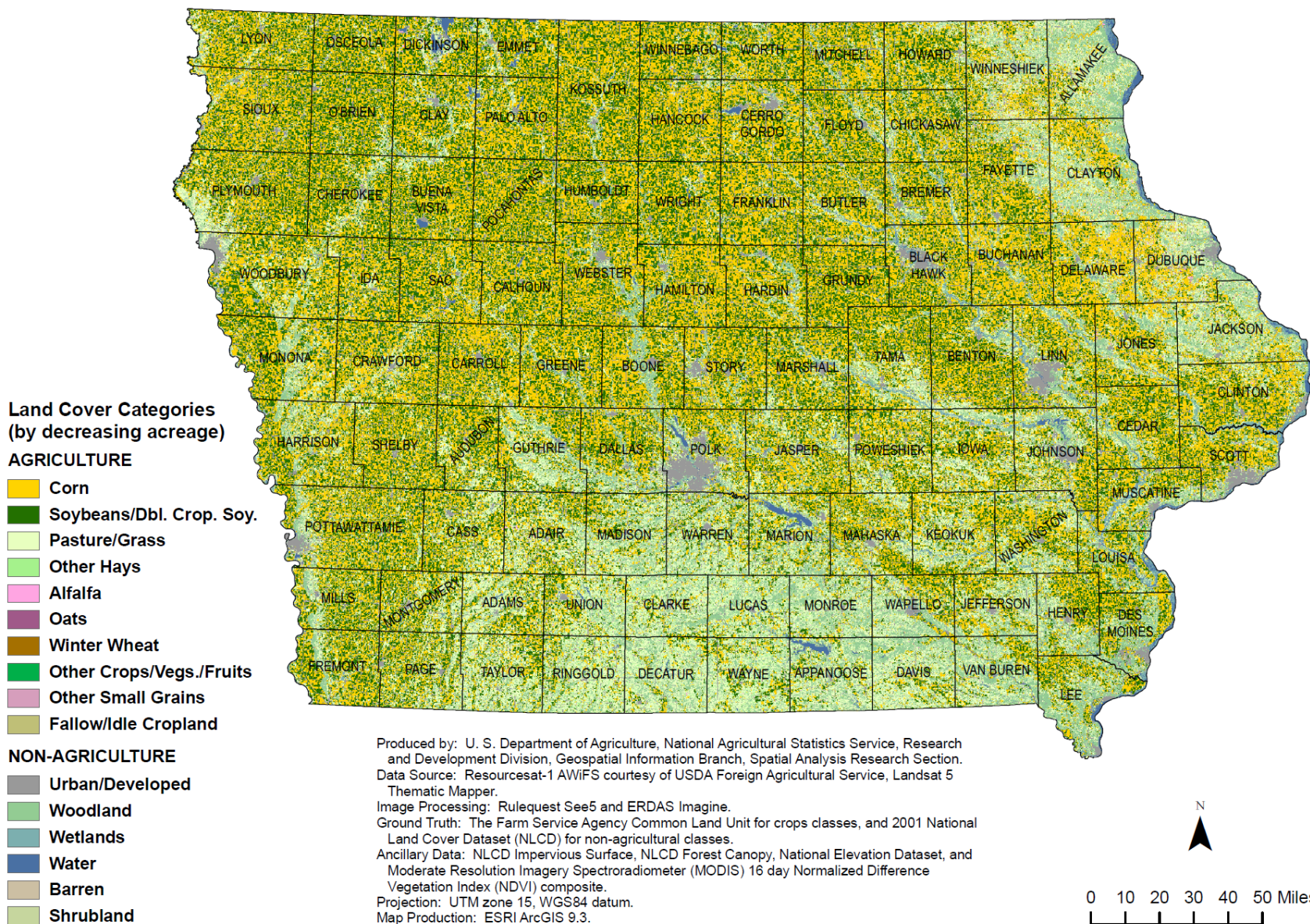
Run classifier



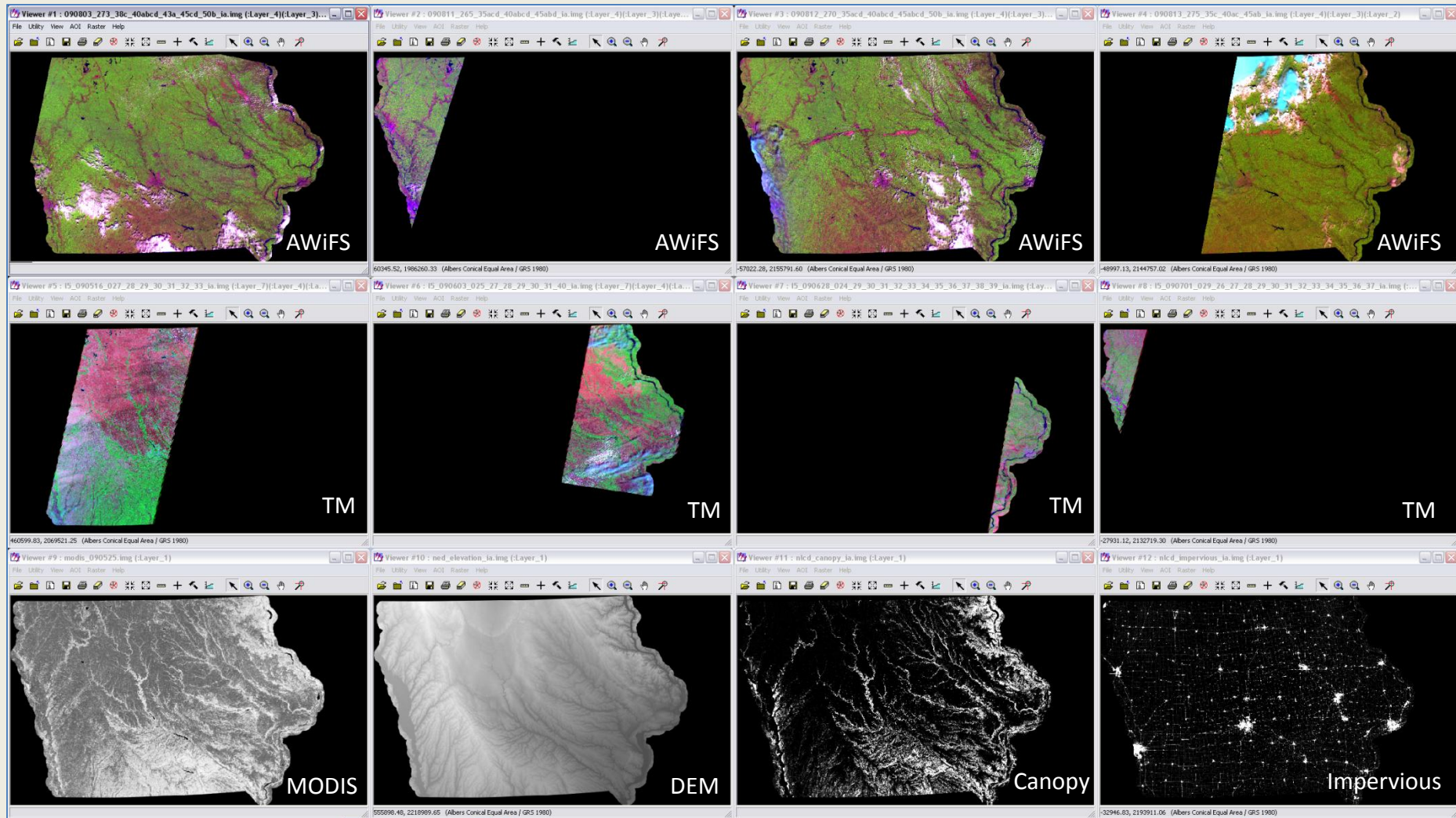
Output land cover map



2009 Iowa Cropland Data Layer

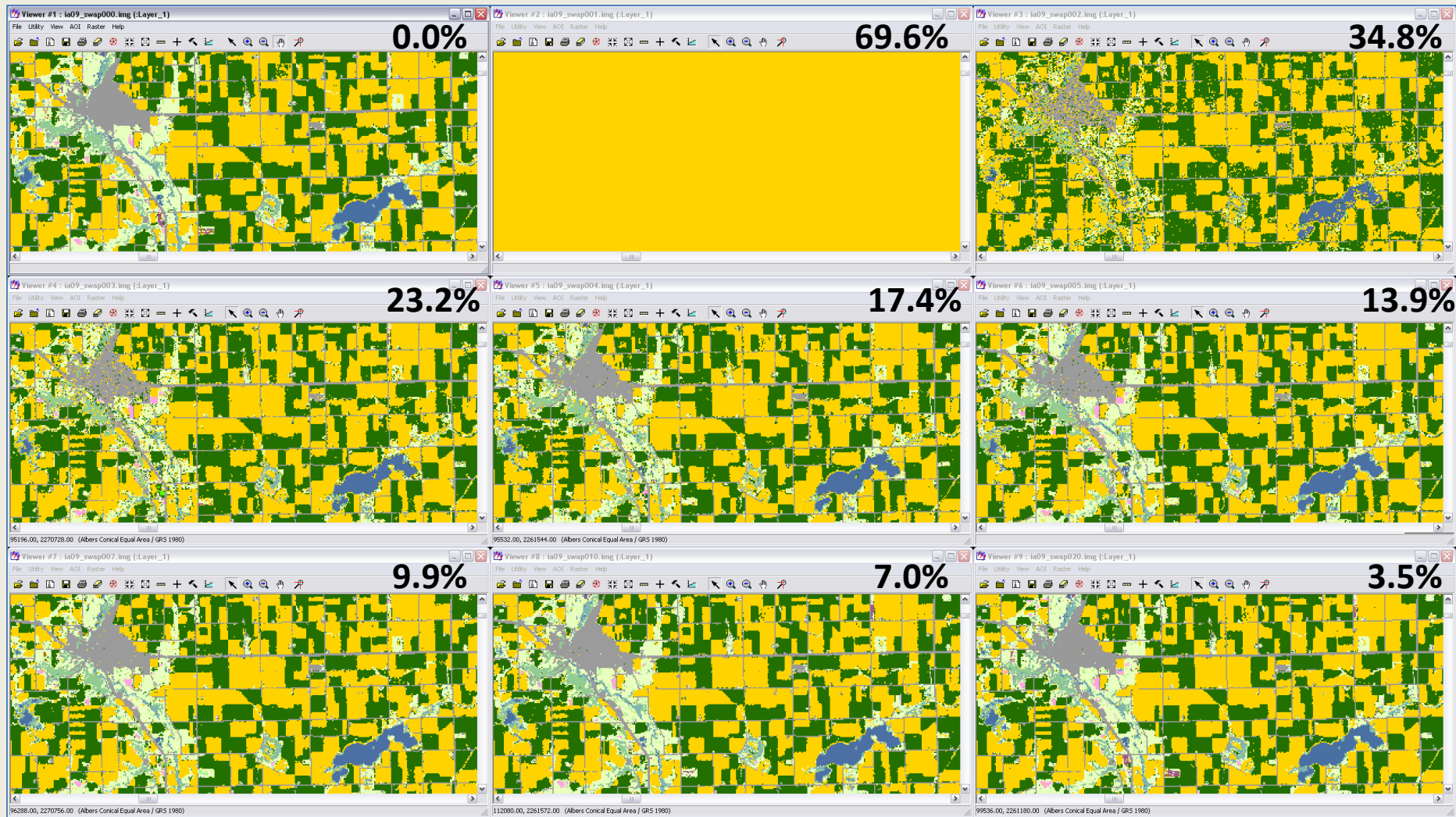


Iowa '09 CDL input layer examples



Scenes of data actually used: 10 AWiFS, 10 TM, 2 MODIS NDVI, DEM, Canopy, and Impervious
(dates ranged from 1 April '09 – 8 August '09)

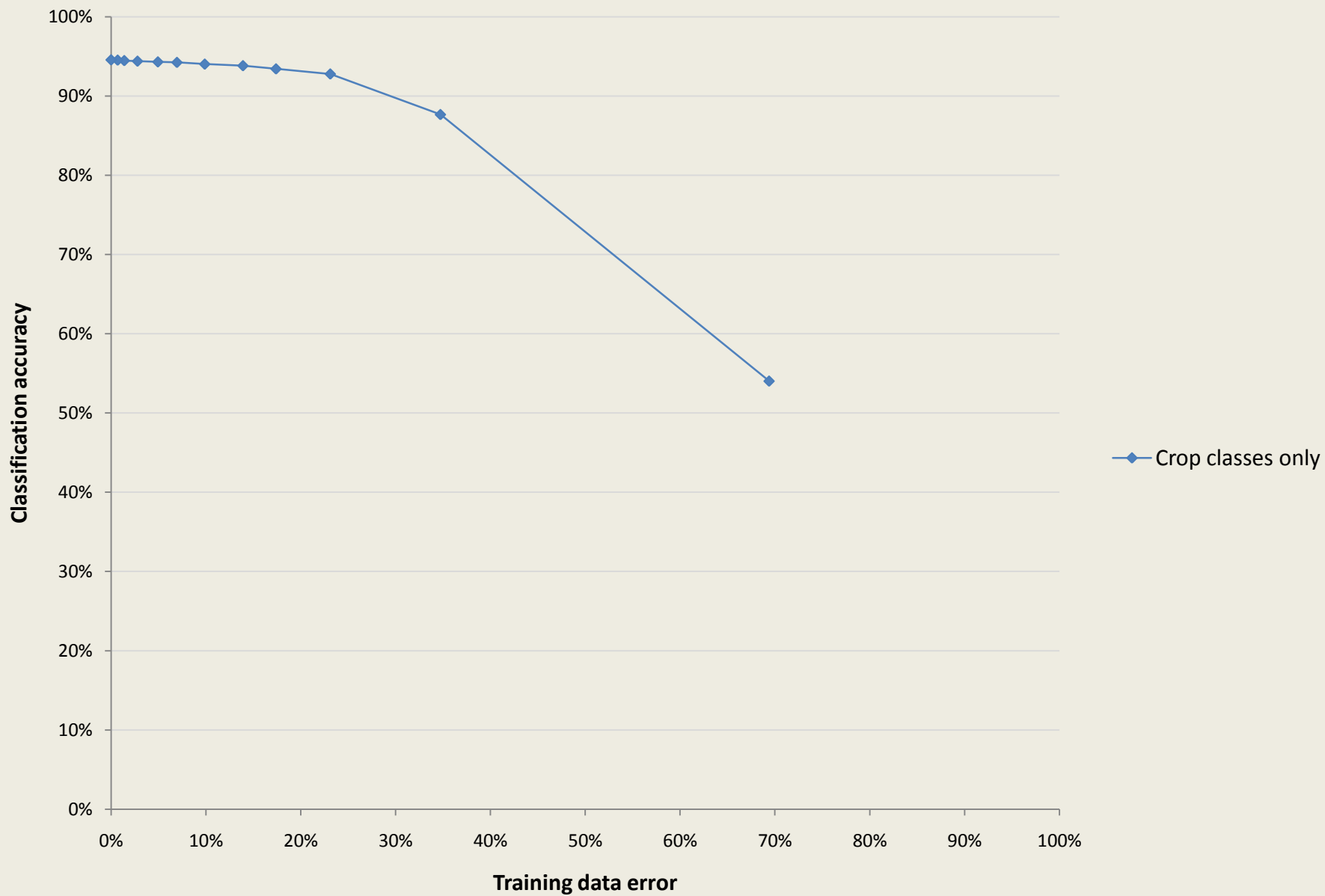
Iowa classifications with training data error %



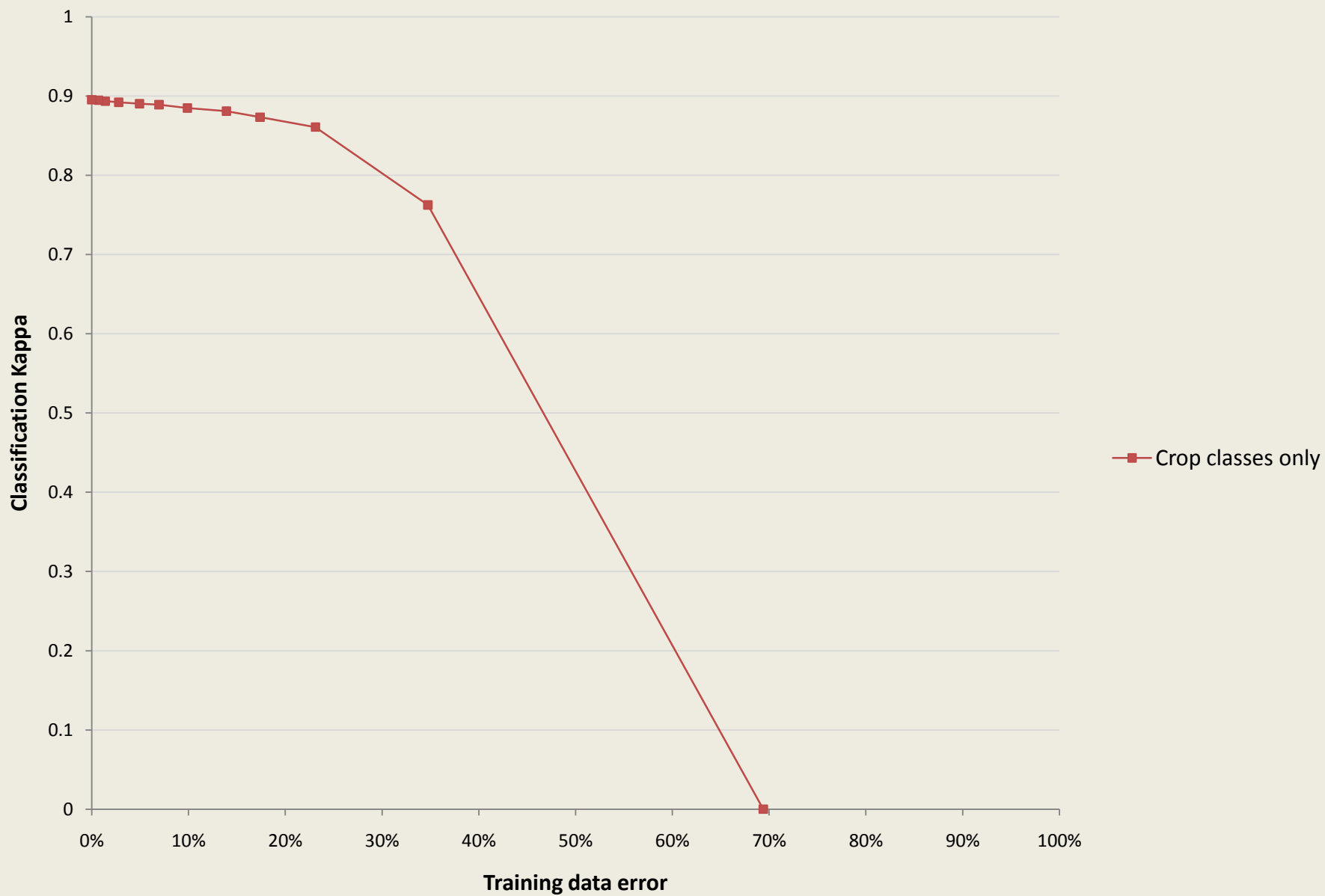
gold = corn, dark green = soybeans

Total scene has 46,474,682 pixels, 755,116 (1.6%) chosen for training

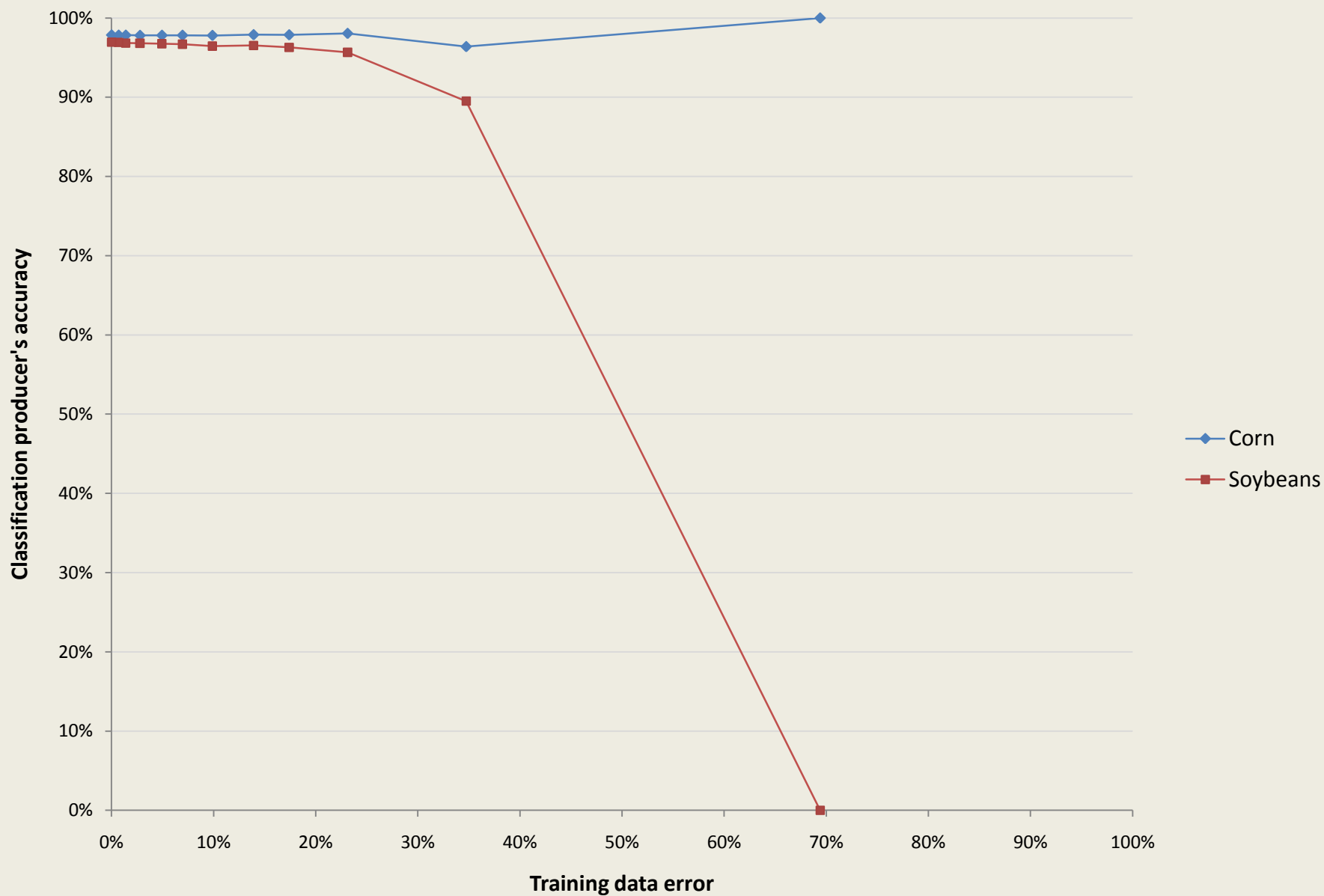
Iowa '09 CDL, Classification accuracy v. training data error



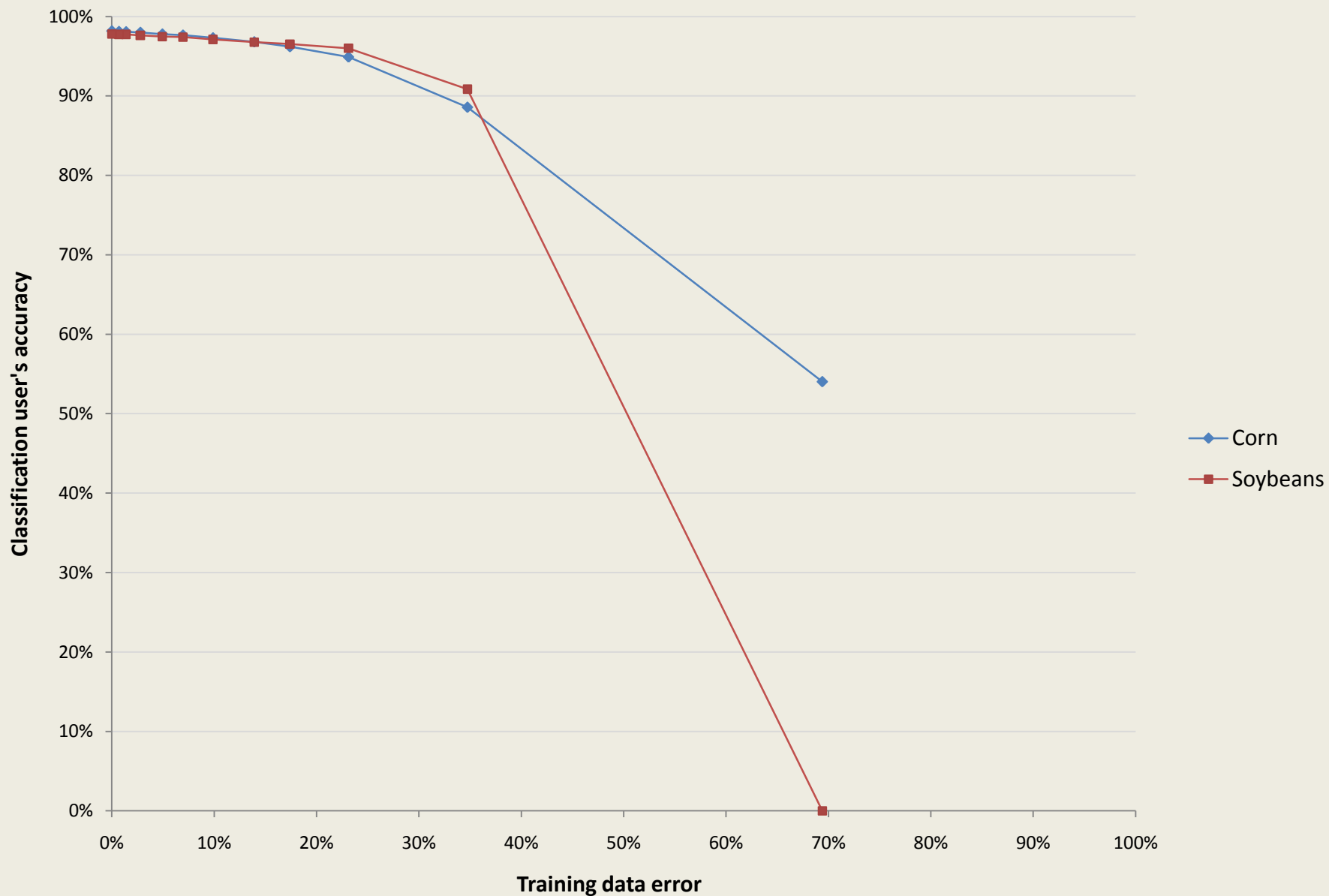
Iowa '09 CDL, Classification Kappa v. training data error



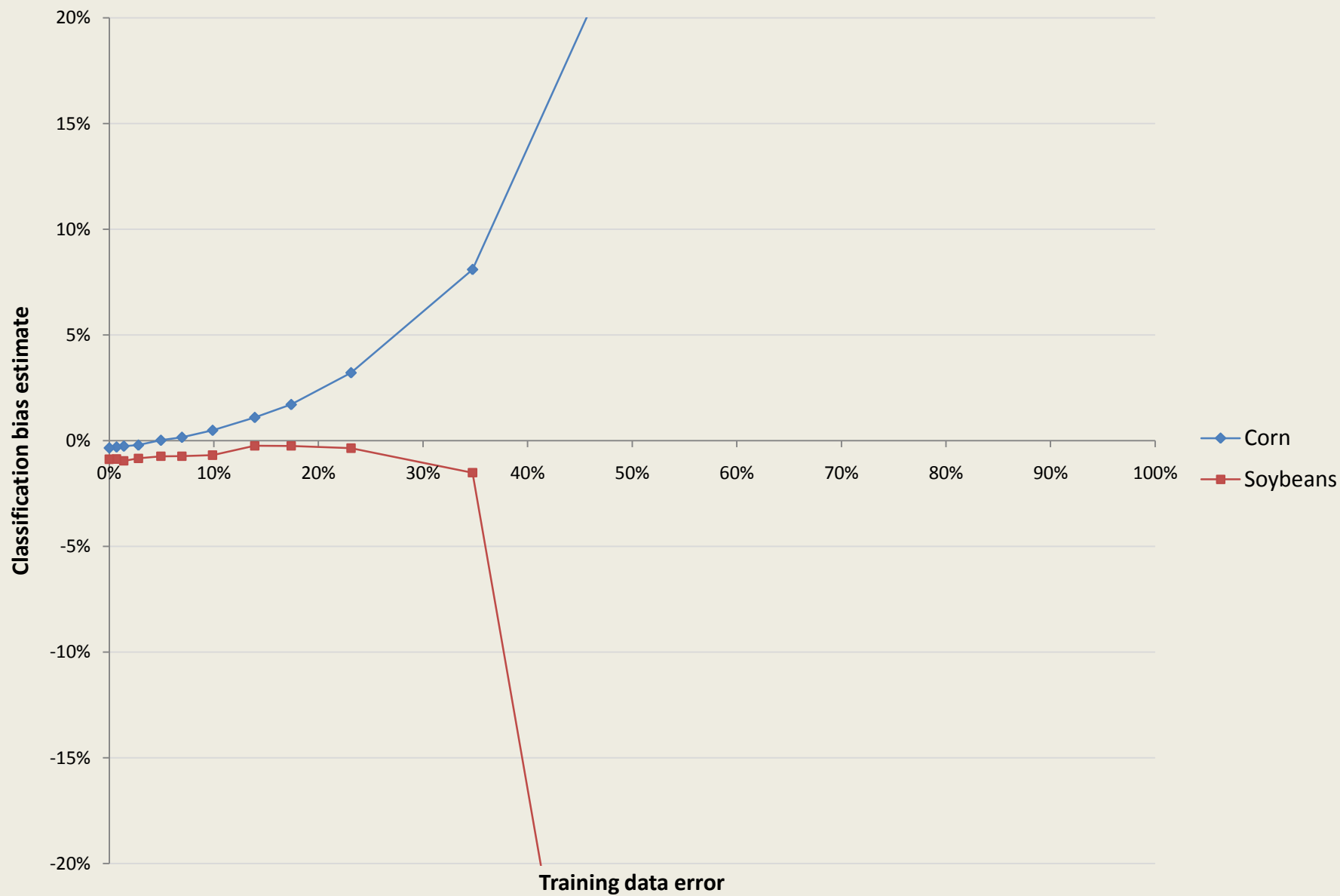
Iowa '09 CDL, Classification producer's accuracy v. training data error



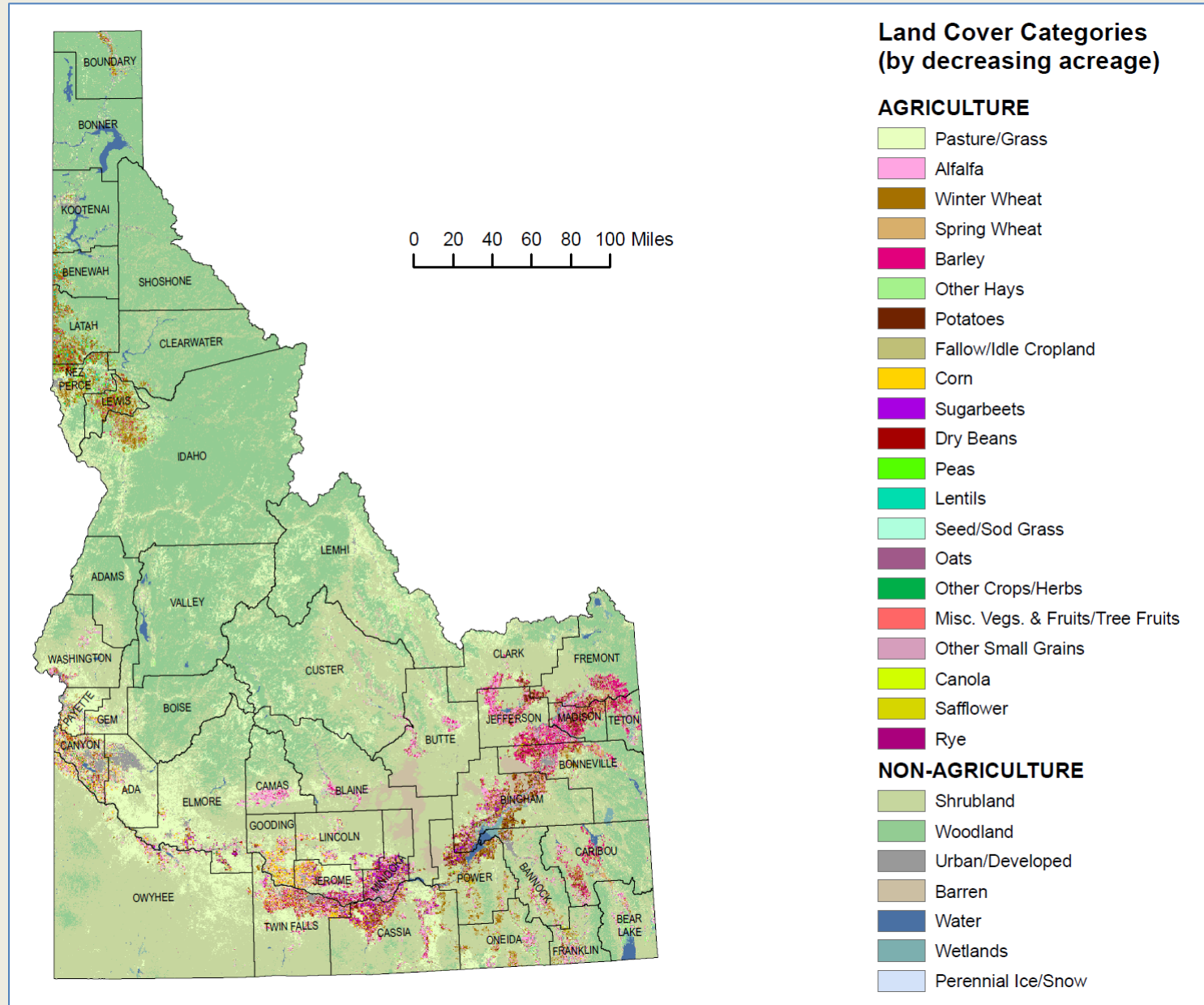
Iowa '09 CDL, Classification user's accuracy v. training data error



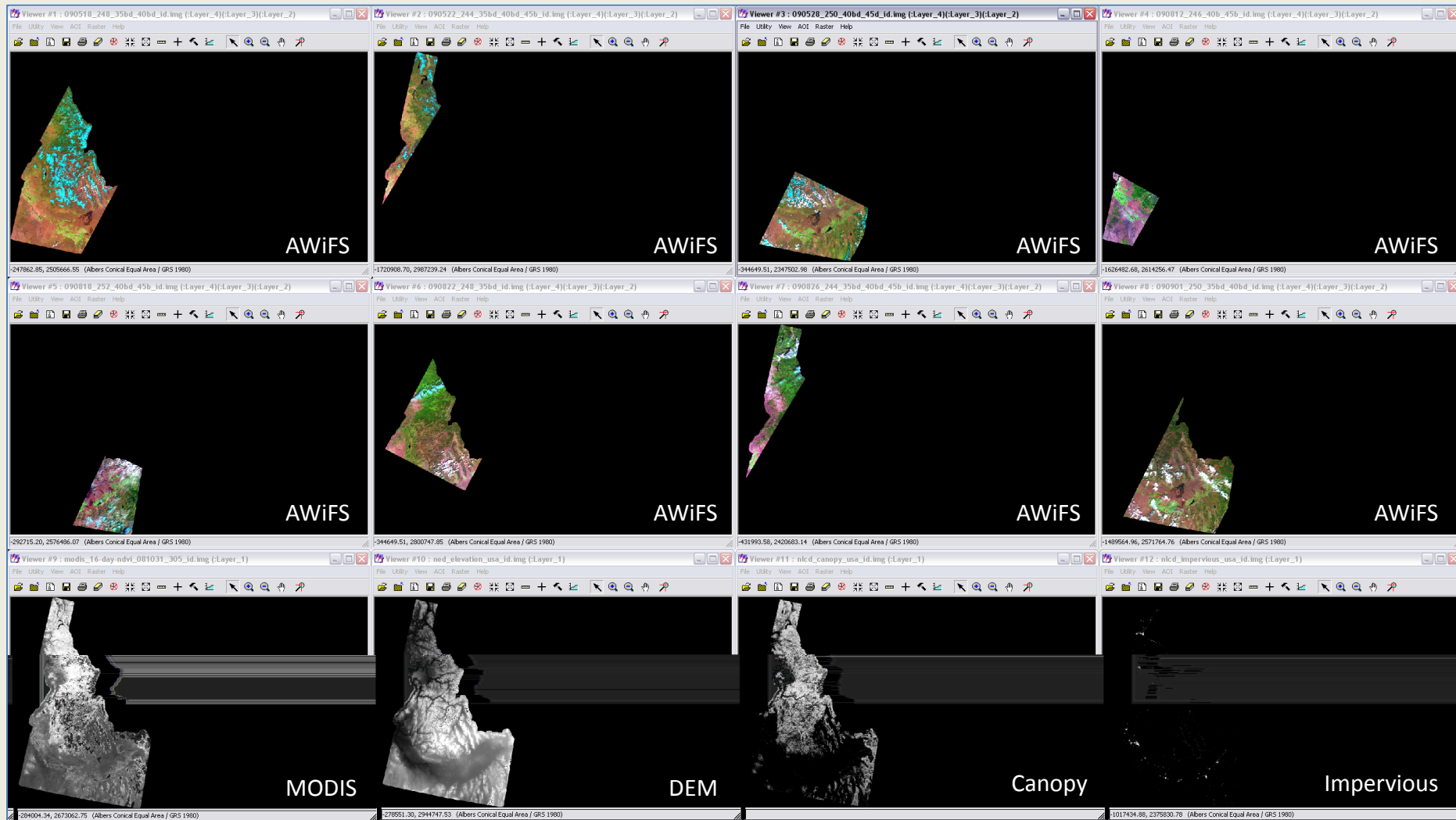
Iowa '09 CDL, Classification bias v. training data error



2009 Idaho Cropland Data Layer

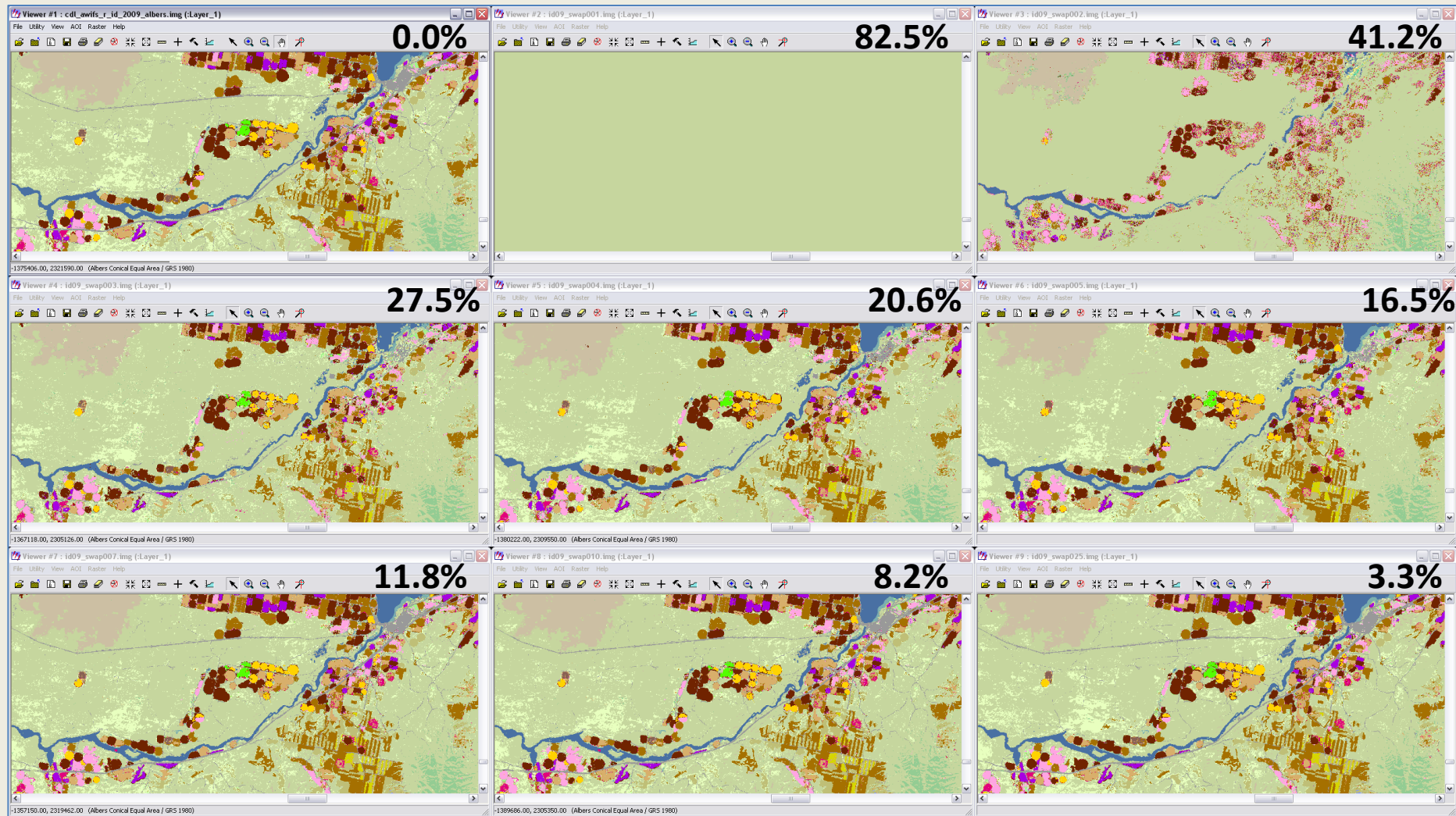


Idaho '09 CDL input layer examples



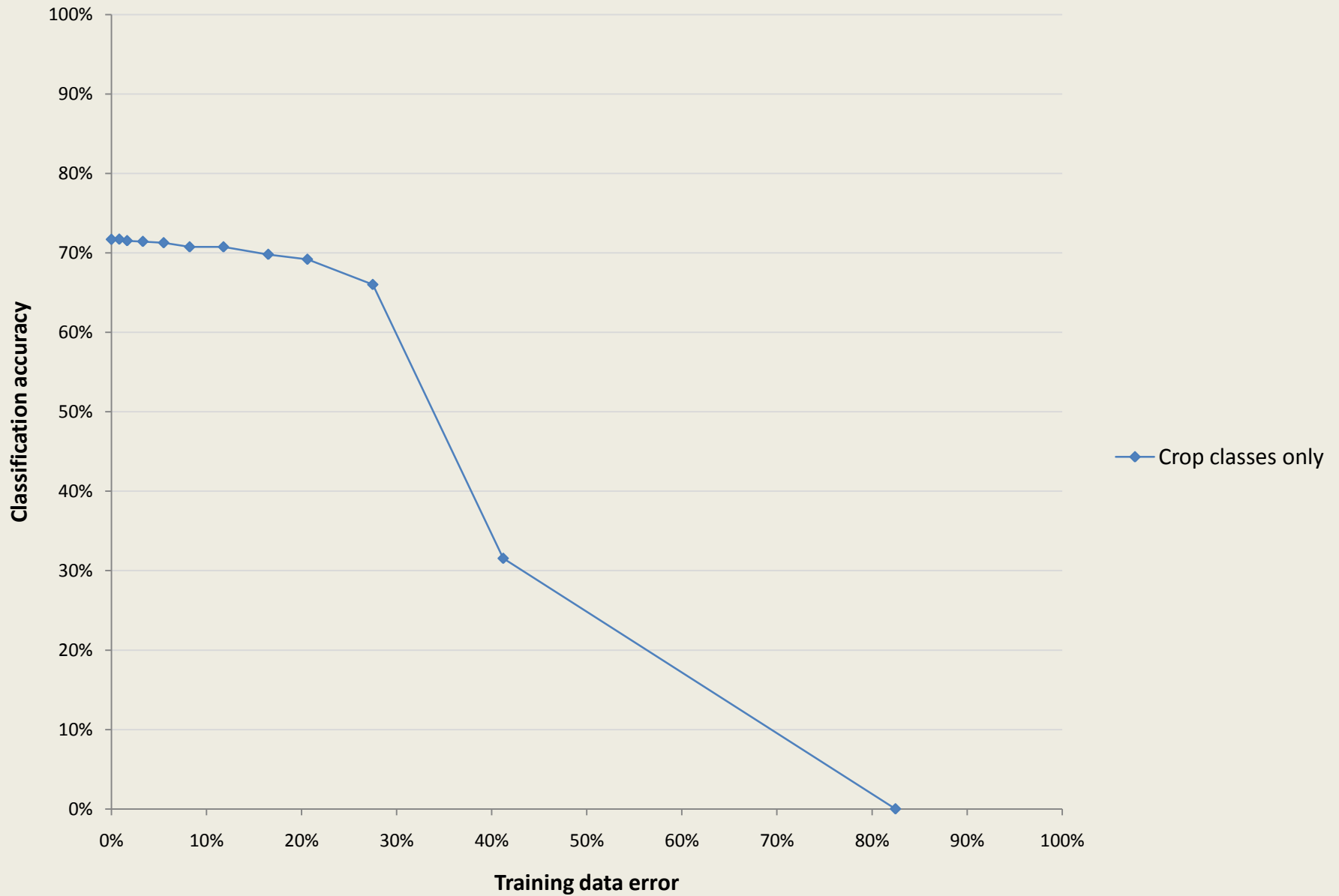
Scenes of data actually used: 15 AWiFS, 7 MODIS NDVI, DEM, Canopy, and Impervious
(dates ranged from 29 September '08 – 1 September '09)

Idaho classifications with training data error %

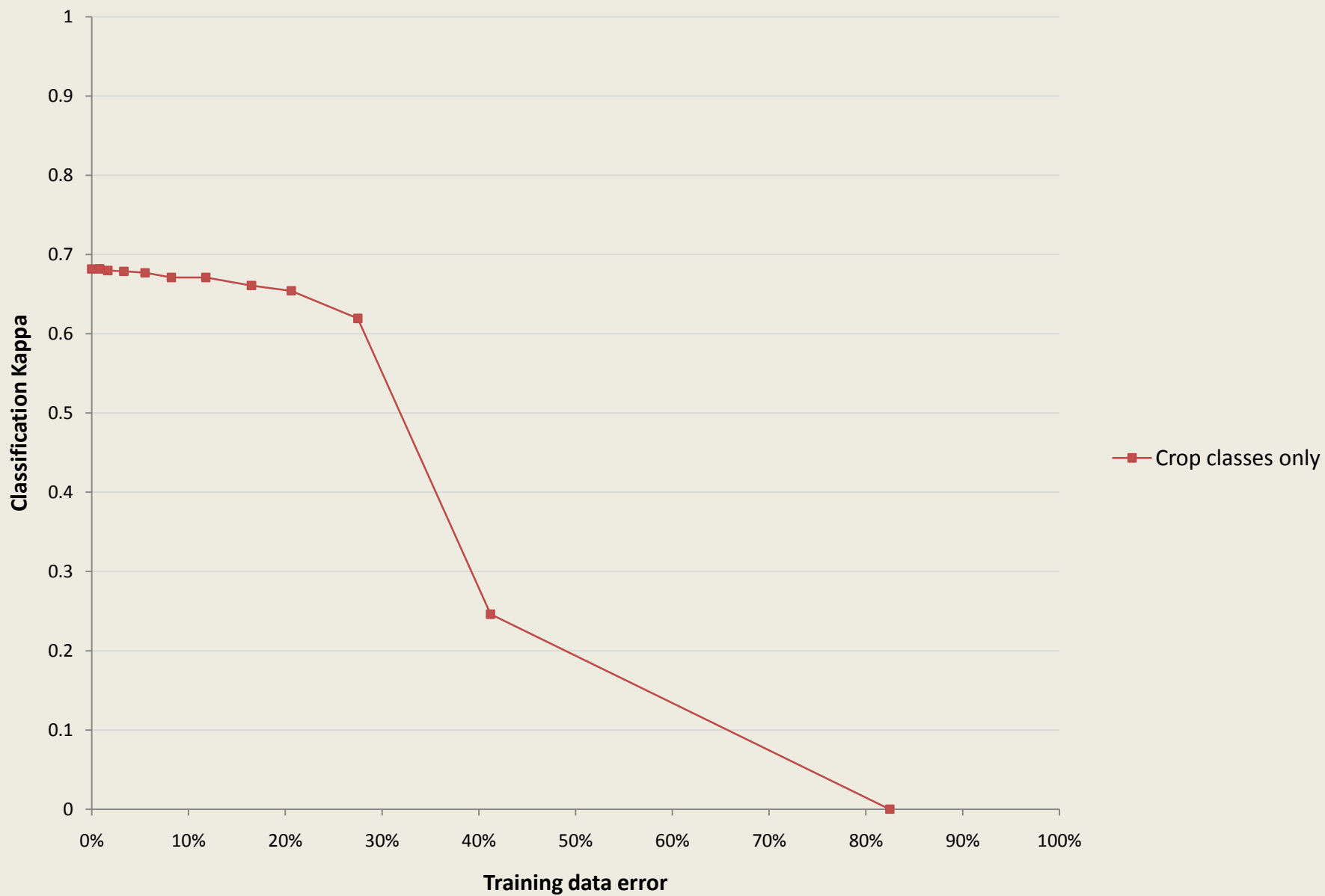


Total scene has 69,018,509 pixels, 891,793 (1.3%) chosen for training

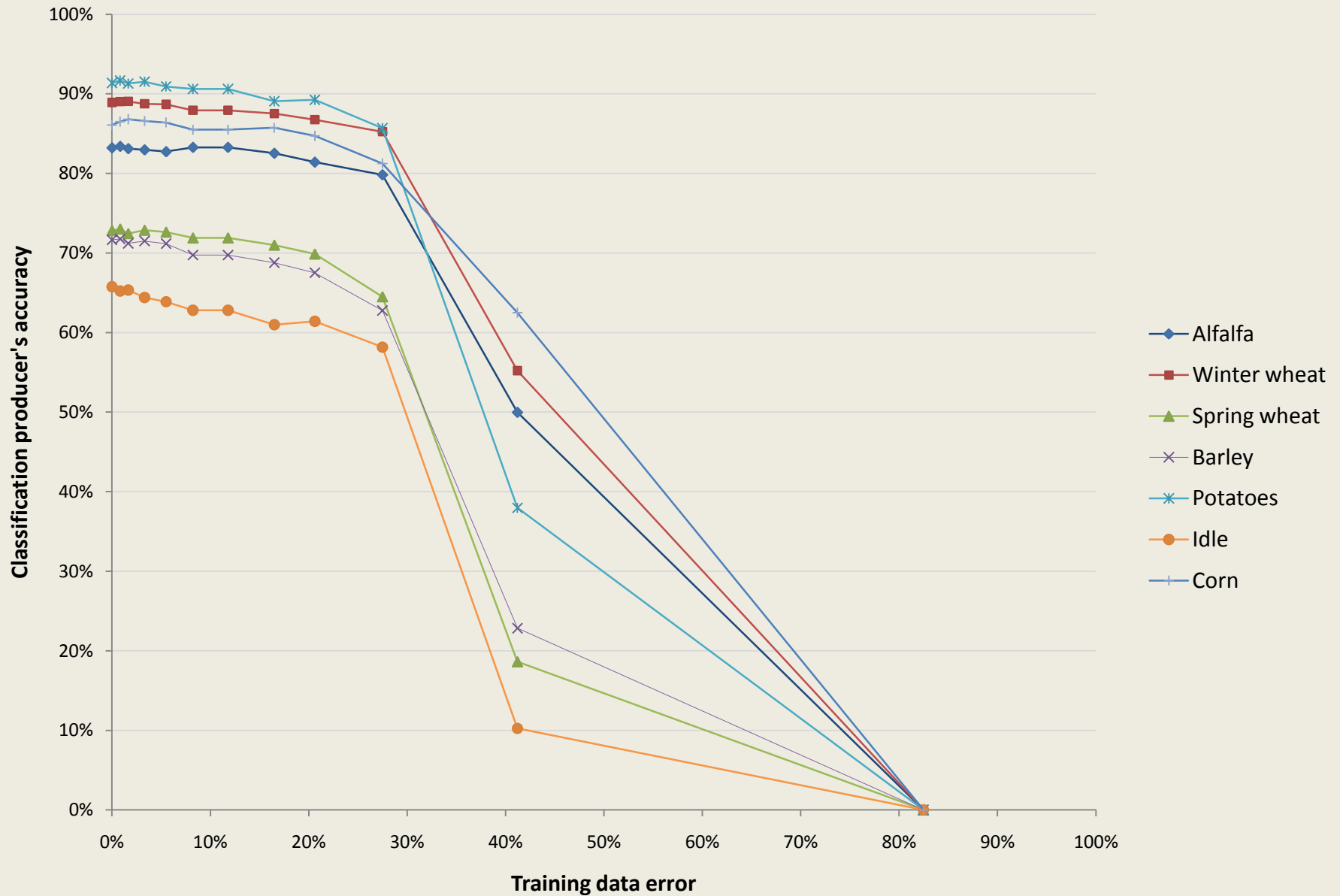
Idaho '09 CDL, Classification accuracy v. training data error



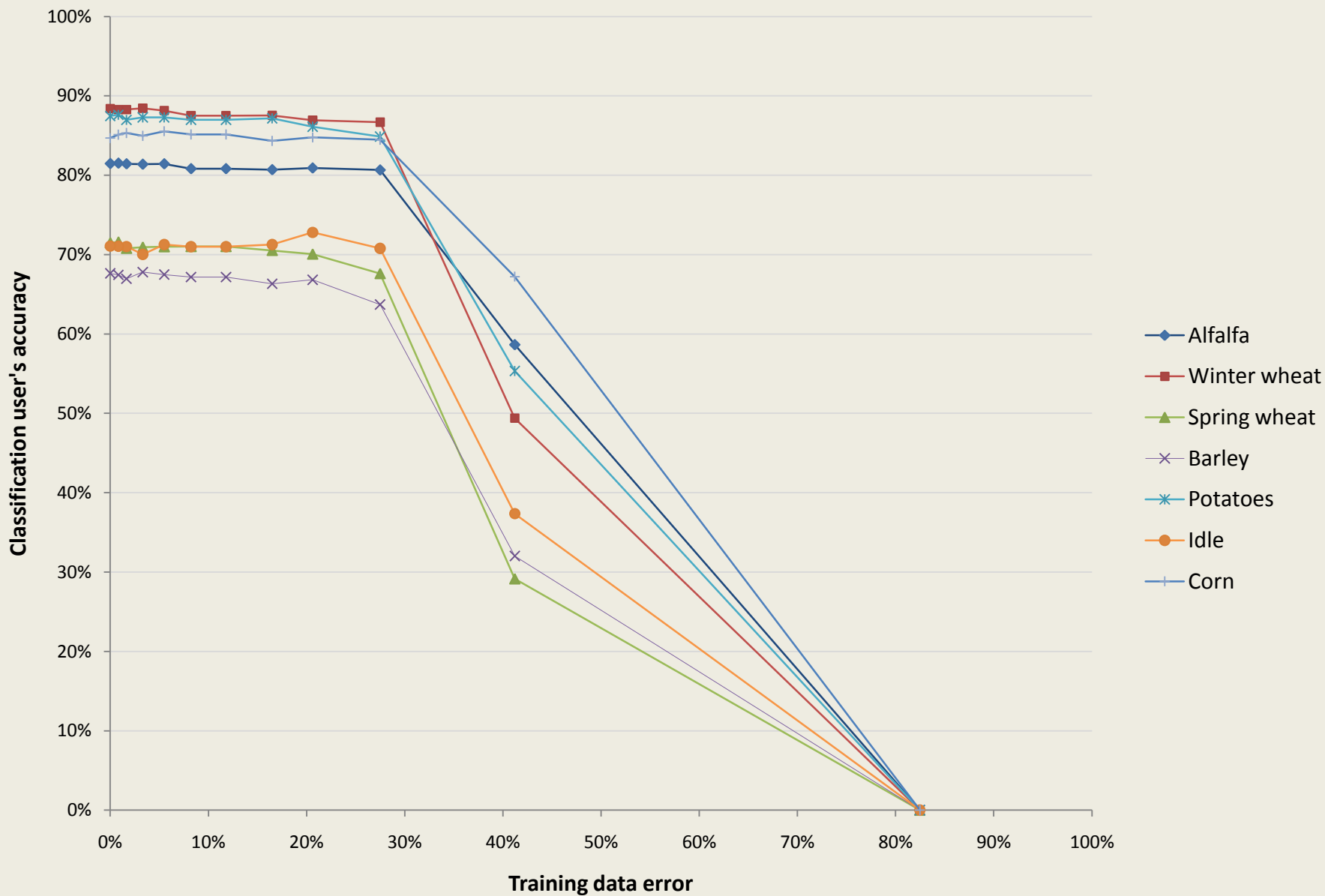
Idaho '09 CDL, Classification Kappa v. training data error



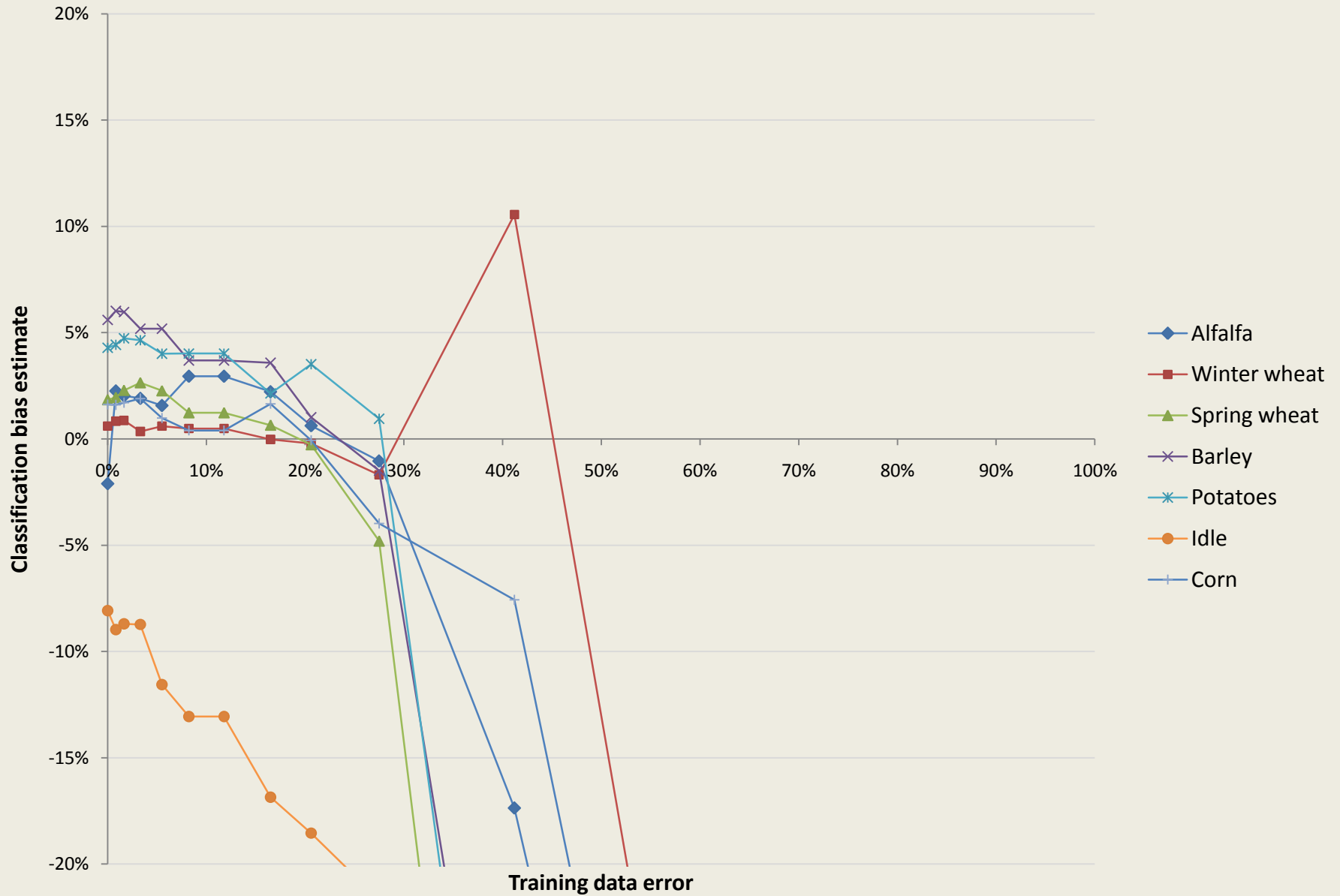
Idaho '09 CDL, Classification producer's accuracy v. training data error



Idaho '09 CDL, Classification user's accuracy v. training data error



Idaho '09 CDL, Classification bias v. training data error



2009 North Dakota Cropland Data Layer

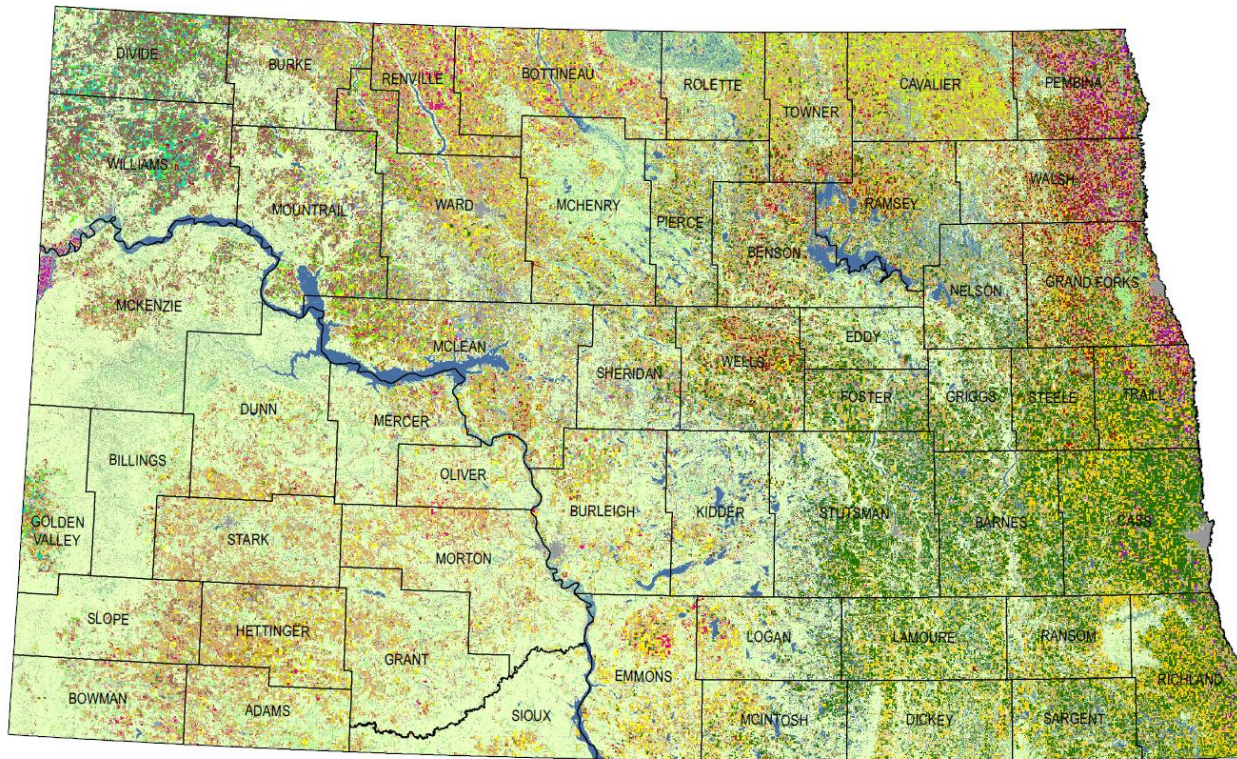
Land Cover Categories (by decreasing acreage)

AGRICULTURE

- Pasture/Grass
- Spring Wheat
- Soybeans
- Other Hays
- Corn
- Durum Wheat
- Canola
- Sunflowers
- Dry Beans
- Barley
- Winter Wheat
- Peas
- Alfalfa
- Fallow/Idle Cropland
- Flaxseed
- Sugarbeets
- Lentils
- Oats
- Potatoes
- Other Crops/Vegs./Fruits
- Millet
- Safflower
- Sorghum
- Rye
- Seed/Sod Grass

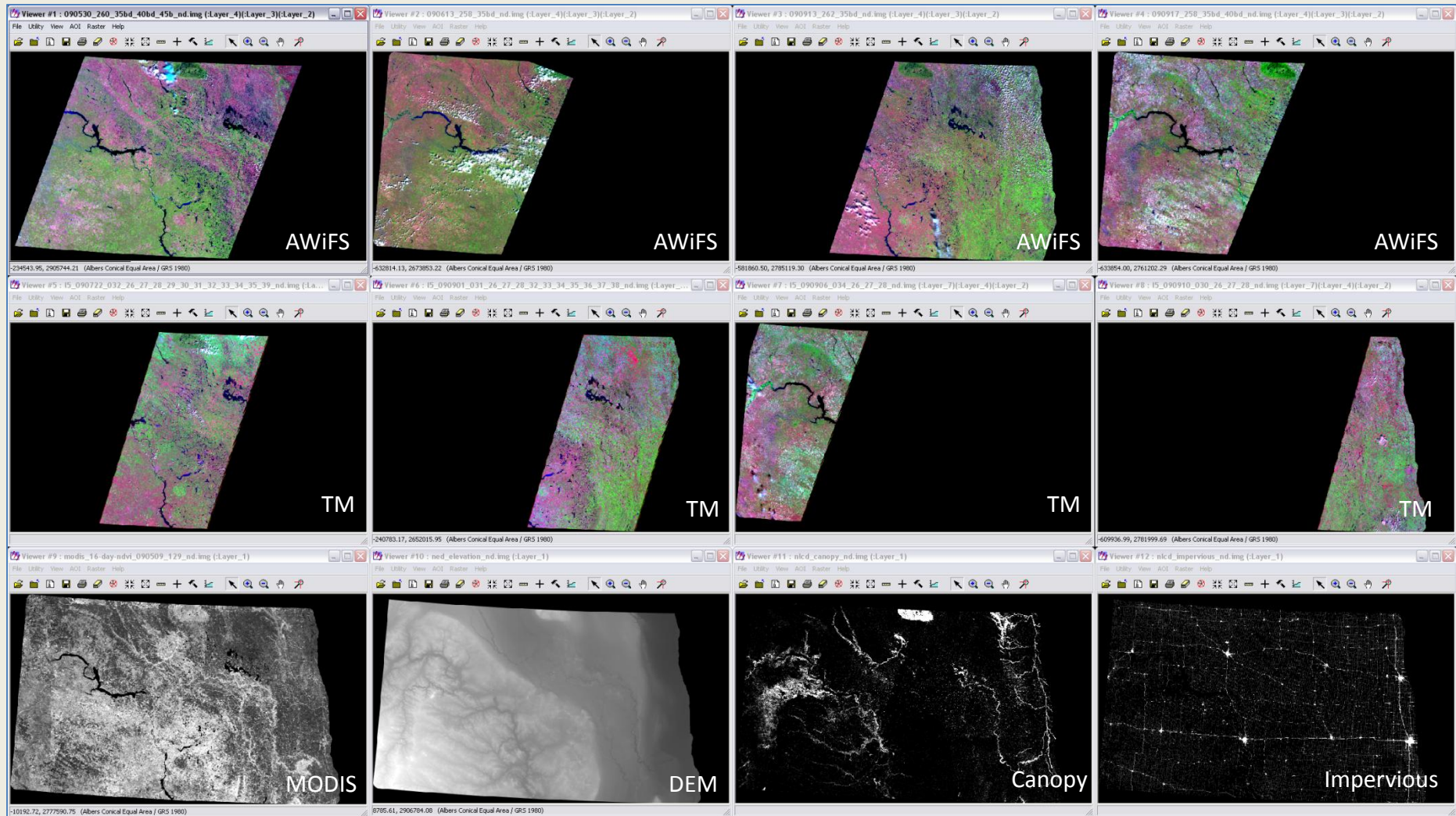
NON-AGRICULTURE

- Urban/Developed
- Wetlands
- Water
- Woodland
- Shrubland
- Barren



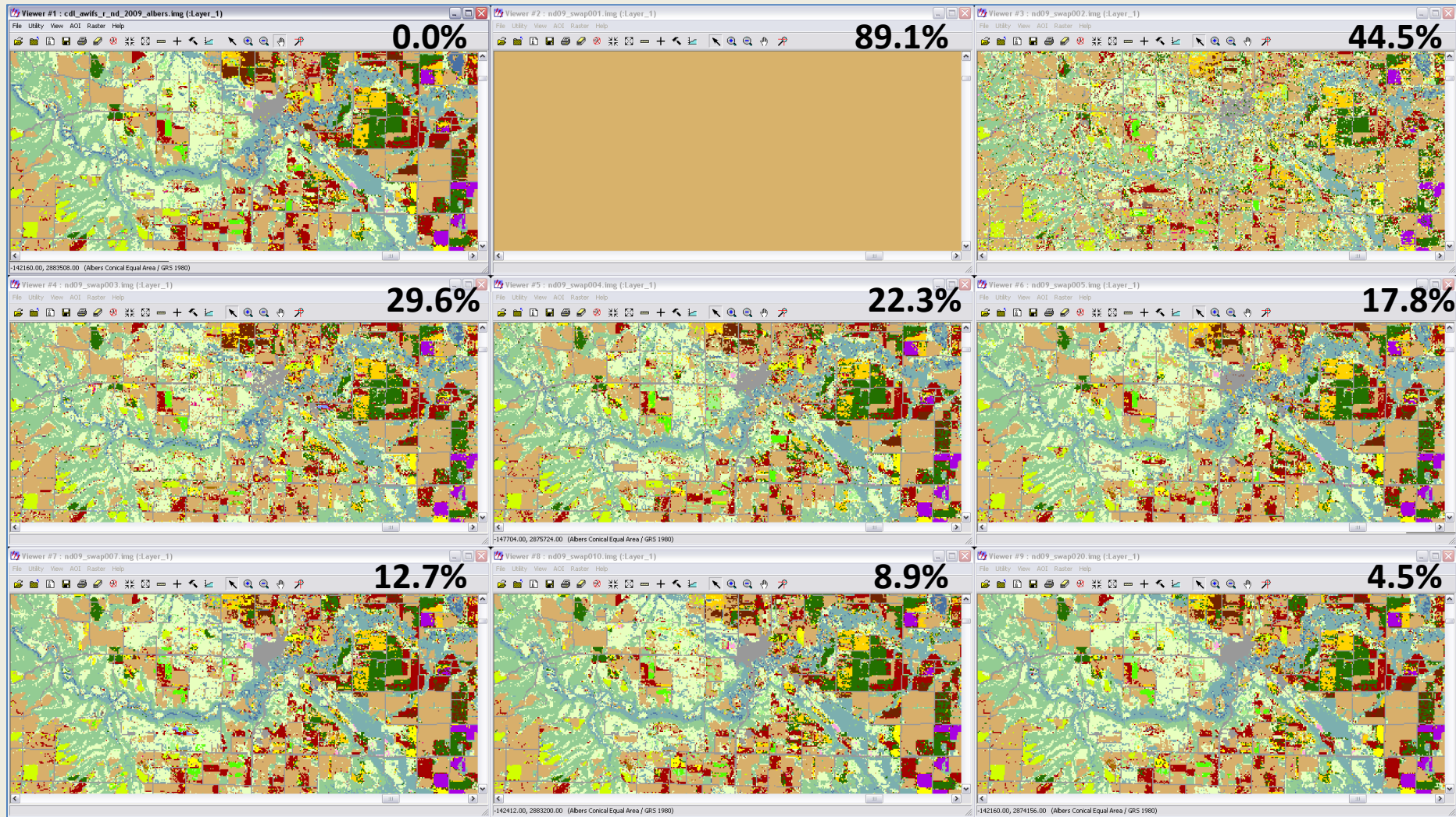
0 20 40 60 80 100 Miles

North Dakota '09 CDL input layer examples



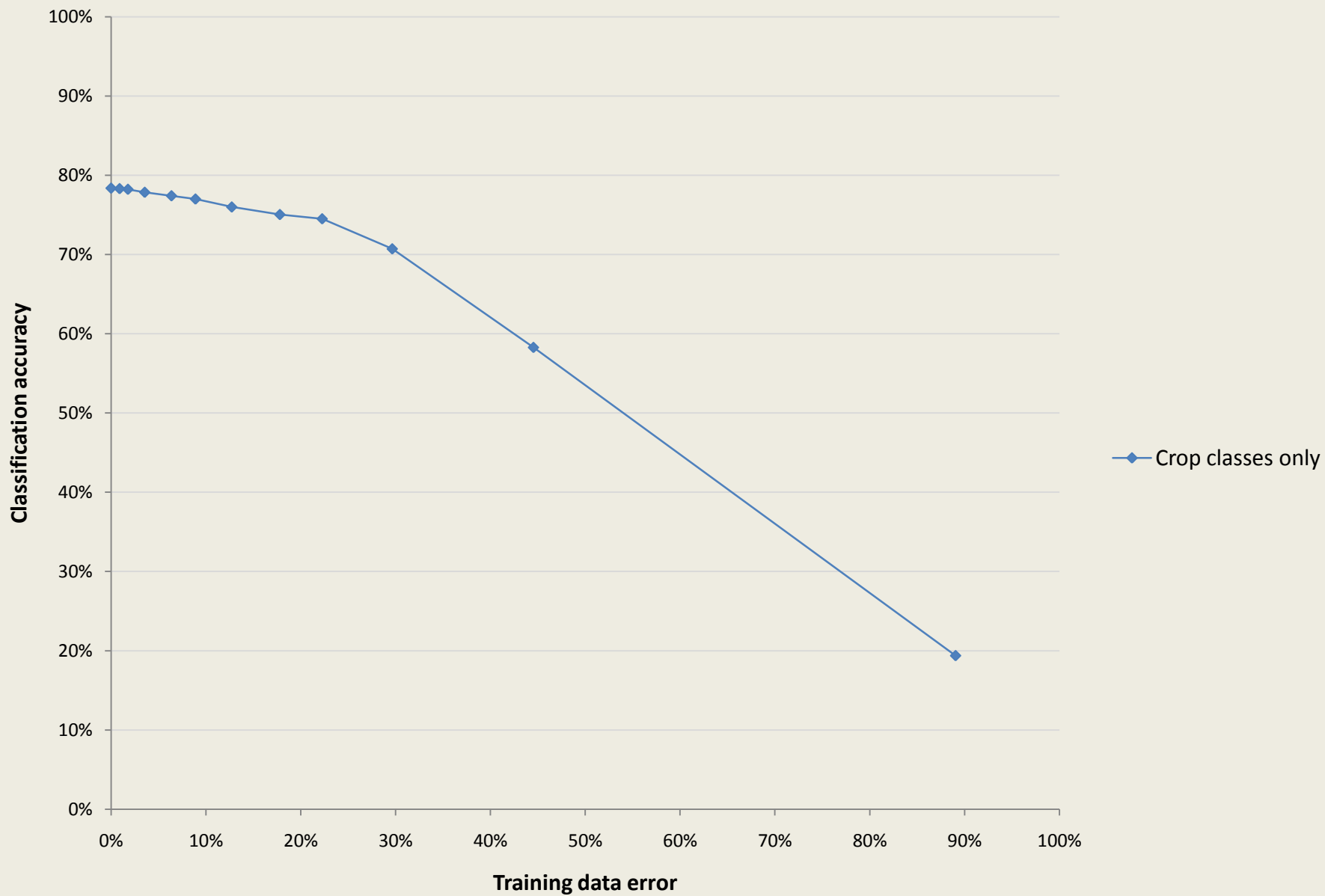
Scenes of data actually used: 14 AWiFS, 13 TM, 1 MODIS NDVI, DEM, Canopy, and Impervious
(dates ranged from 6 May '09 – 17 September '09)

North Dakota classifications with training data error %

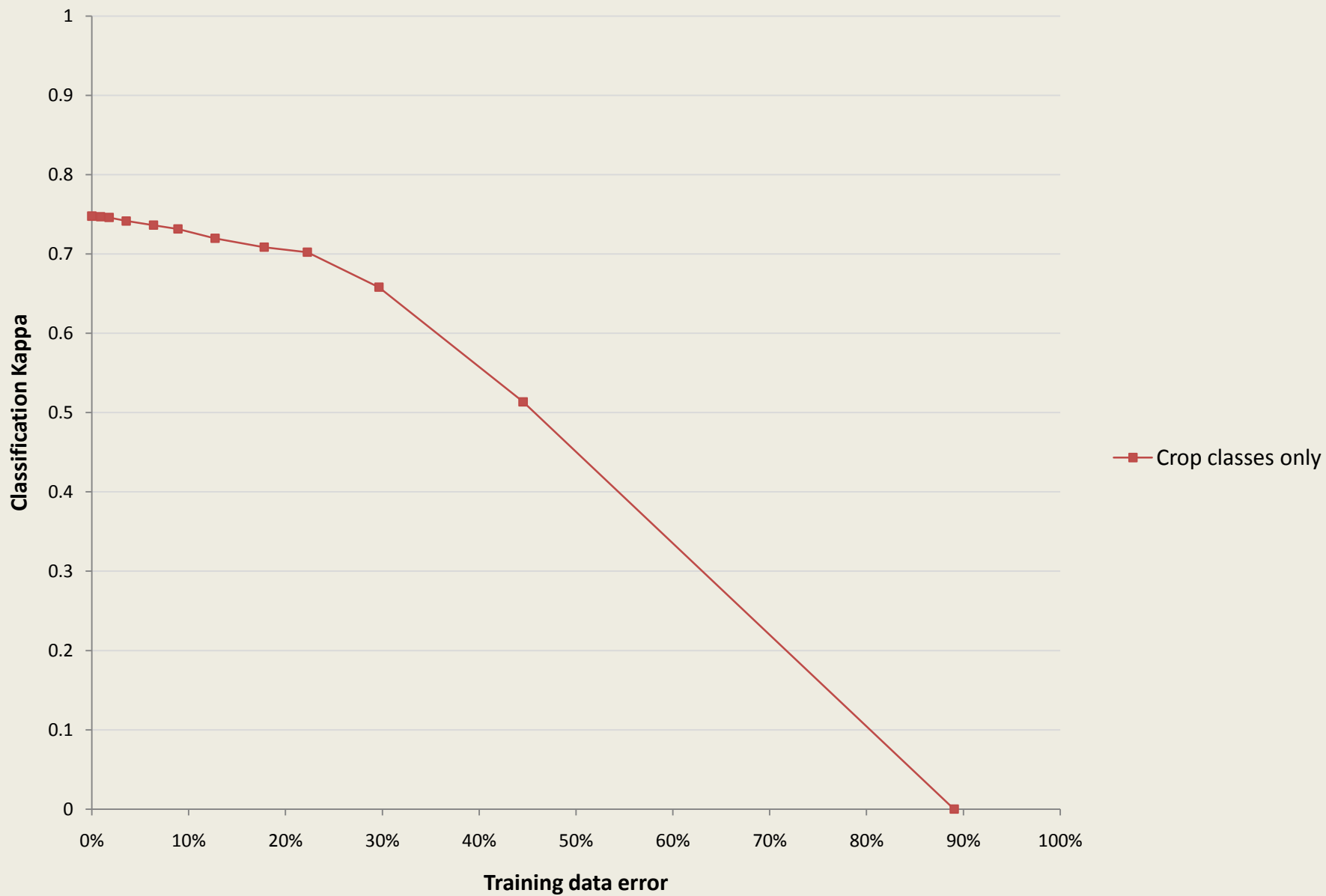


Total scene has 58,388,946 pixels, 737,633 (1.3%) chosen for training

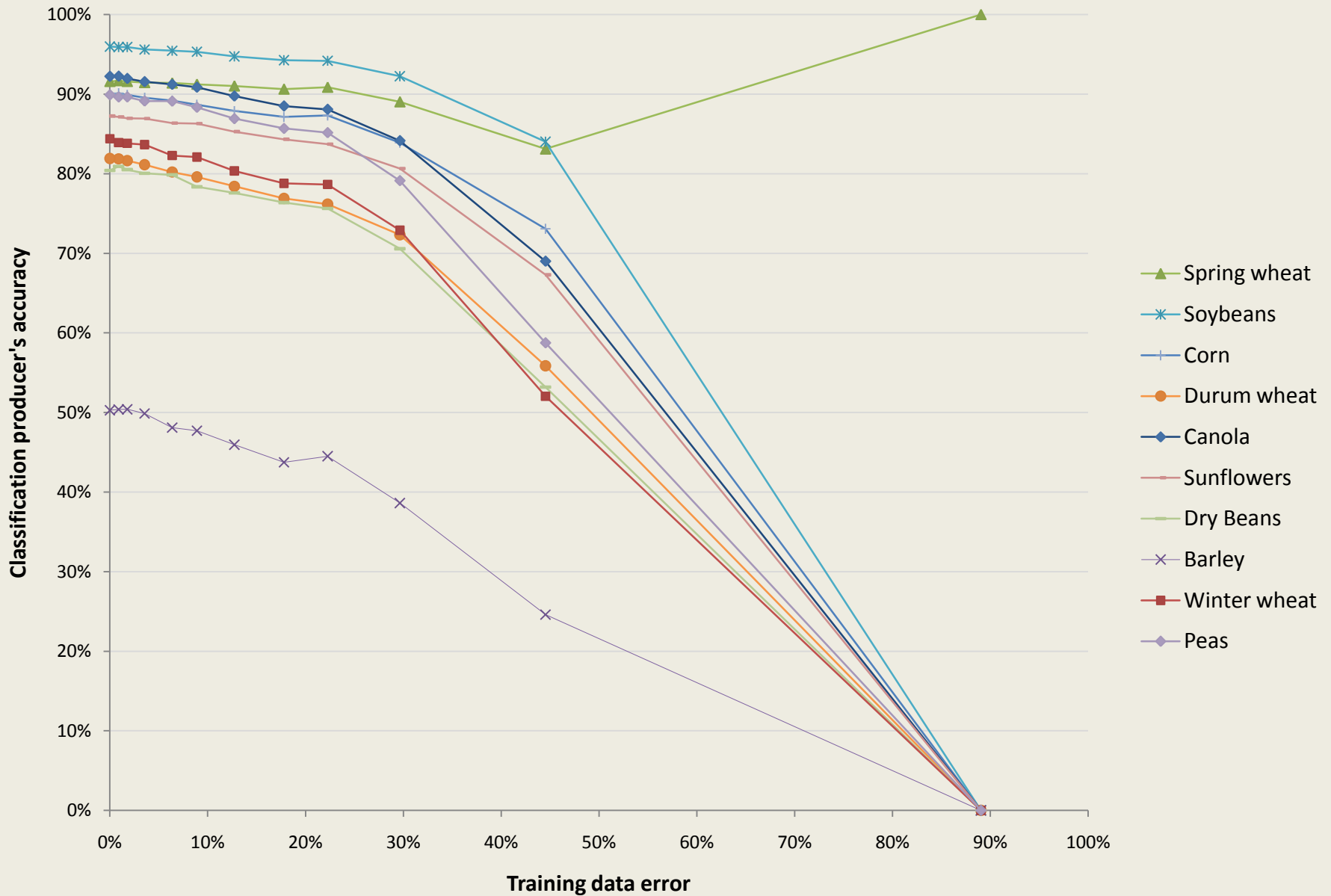
North Dakota '09 CDL, Classification accuracy v. training data error



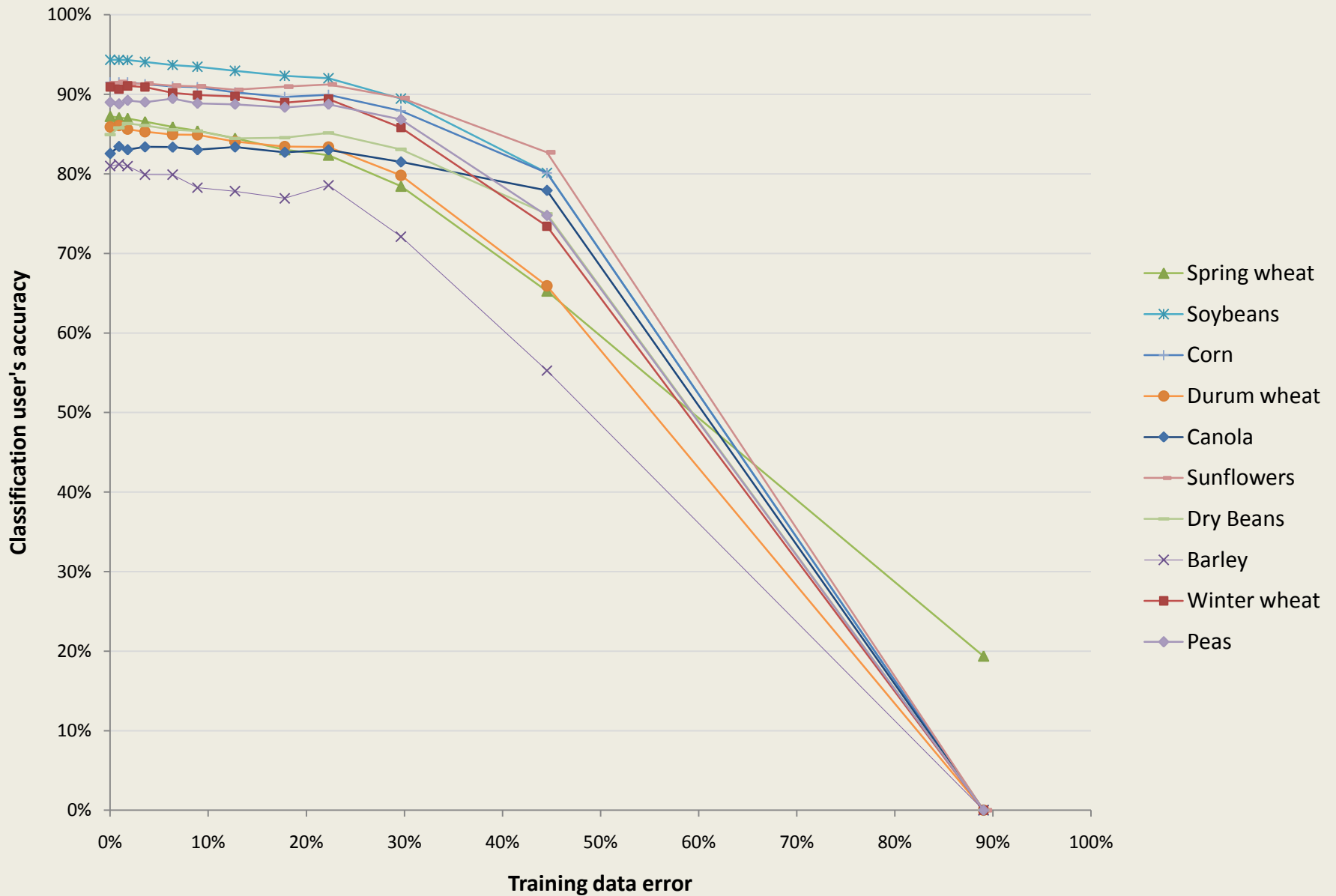
North Dakota '09 CDL, Classification Kappa v. training data error



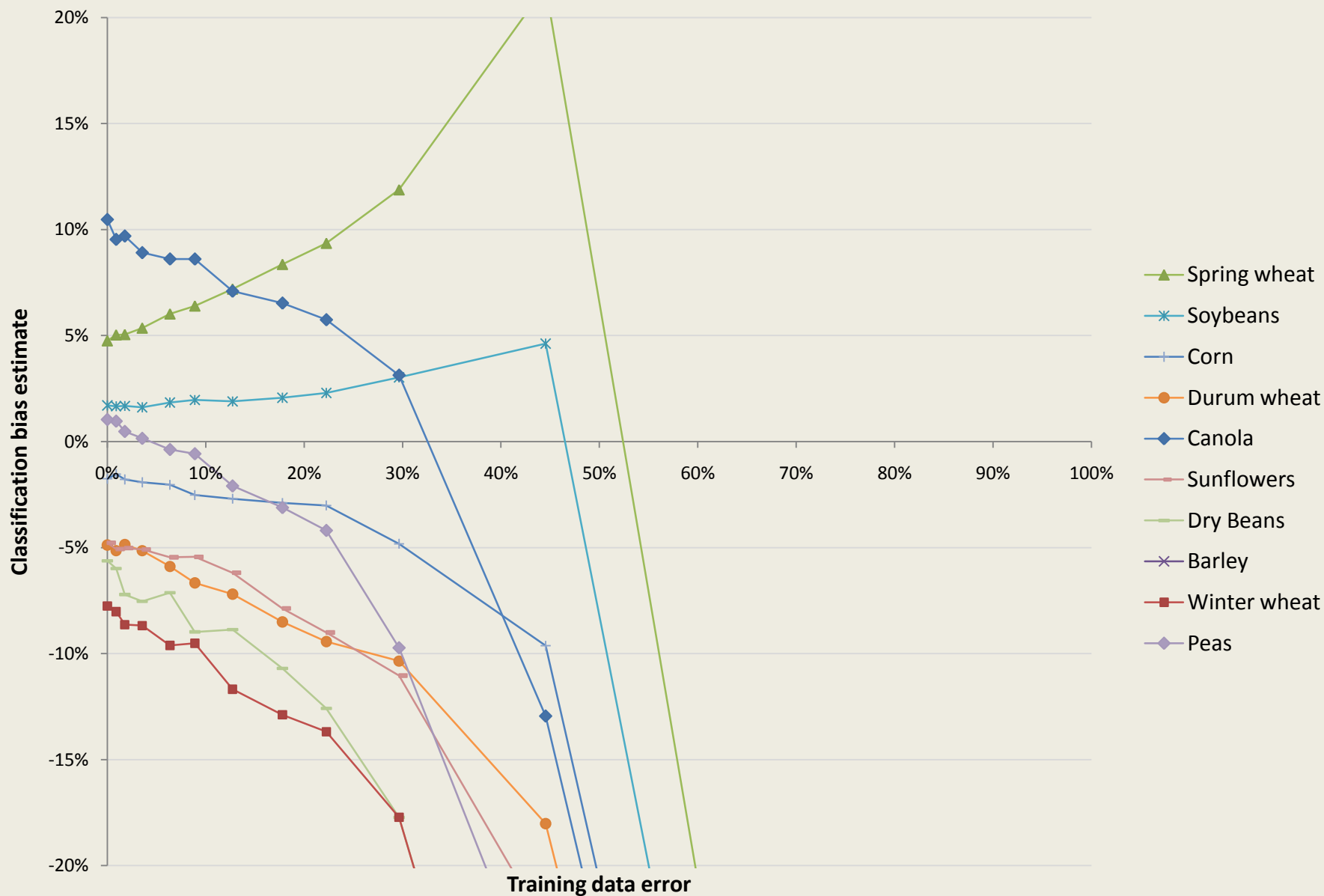
North Dakota '09 CDL, Classification producer's accuracy v. training data error



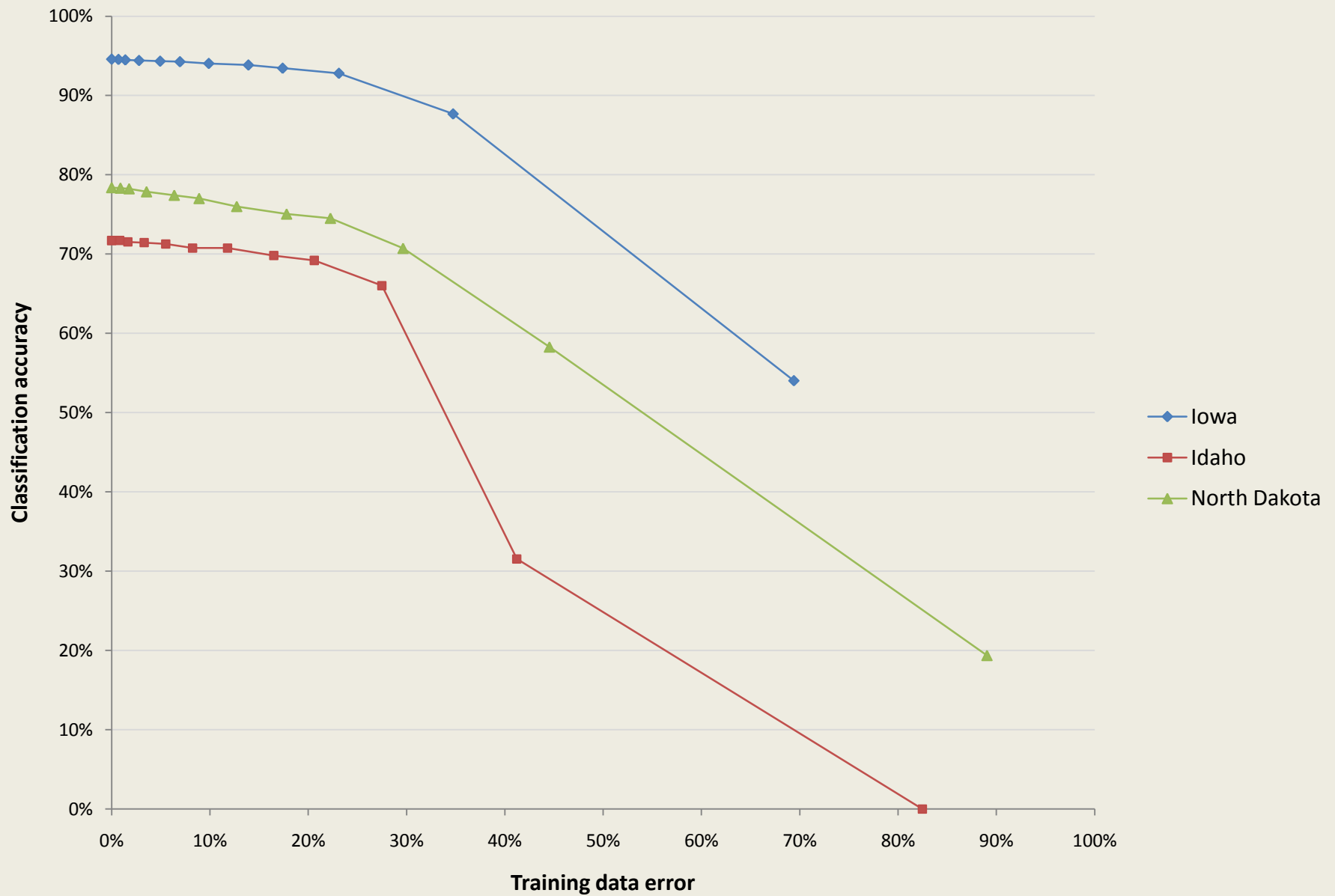
North Dakota '09 CDL, Classification user's accuracy v. training data error



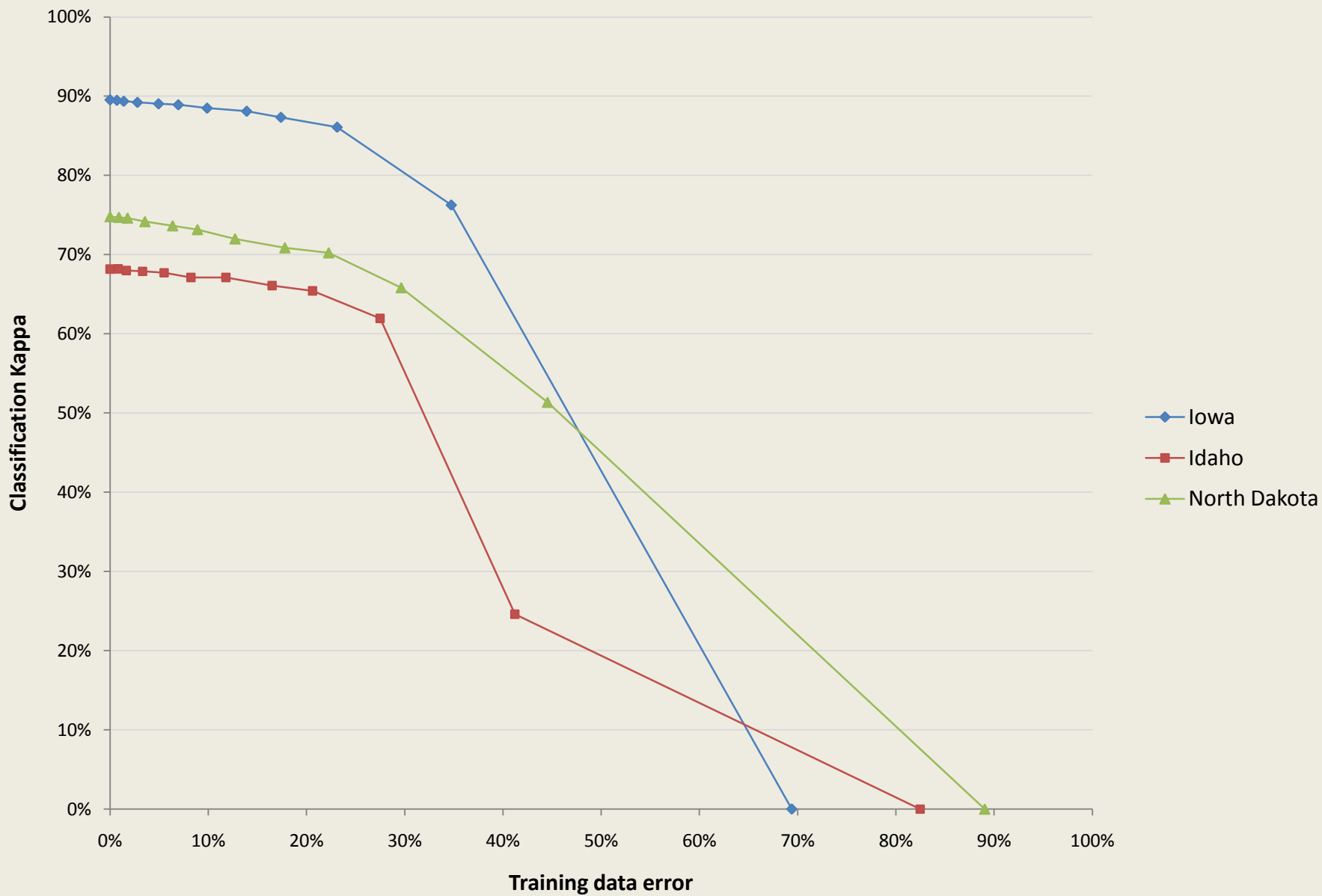
North Dakota '09 CDL, Classification bias v. training data error



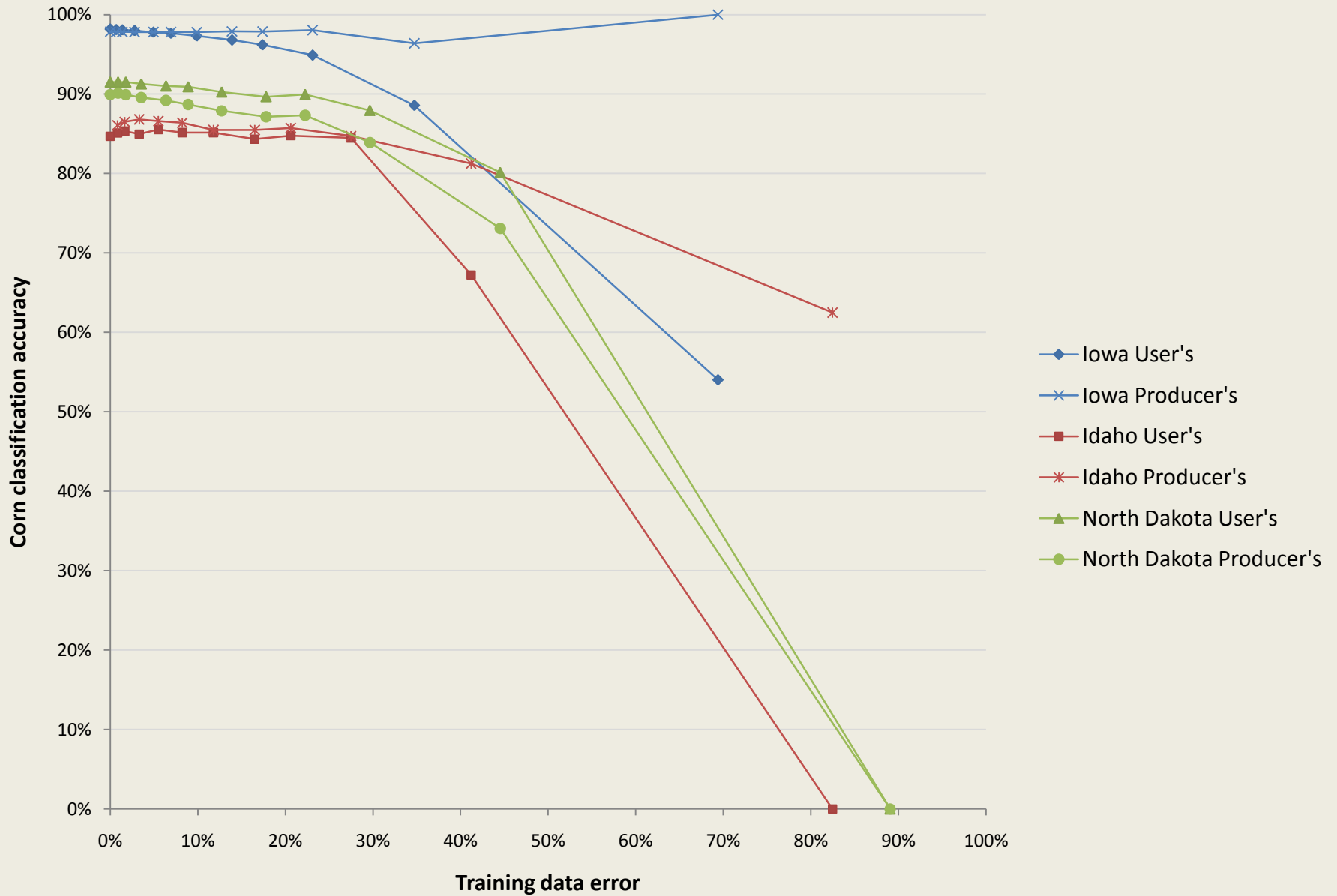
'09 CDL, Cropland classification accuracy v. training data error



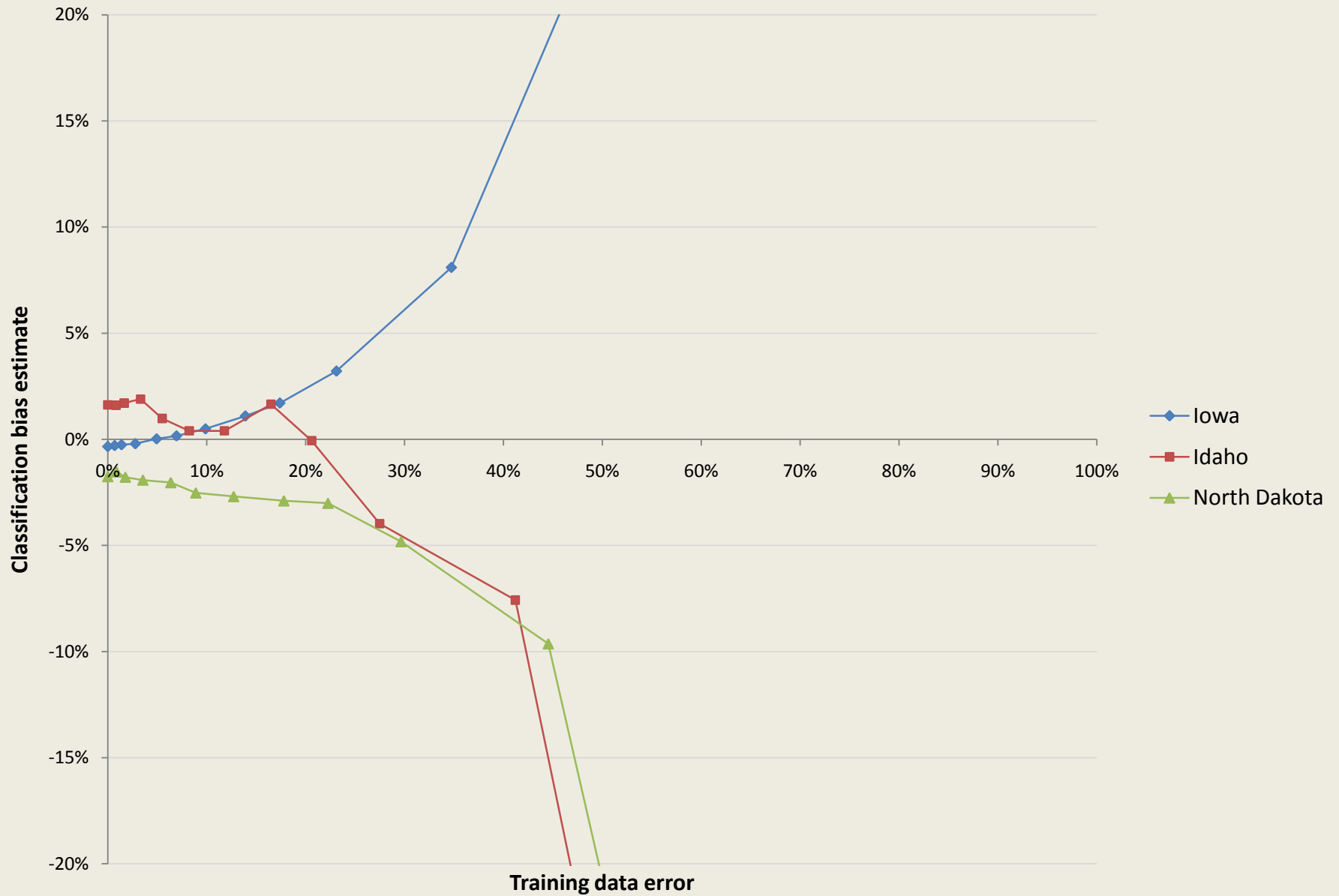
'09 CDL, Cropland classification Kappa v. training data error



'09 CDL, Corn classification accuracy v. training data error



'09 CDL, Corn classification bias v. training data error



Conclusions

- Degradation of training data.....
 - degrades the classification.
 - has relatively modest impacts on the classification until more than roughly 25% of training data is in error (then it falls rapidly, and thus is not linear).
 - hurts the classification more when lots of classes are present.
 - never improves a classification.
 - impacts differently the areal bias of categories within the classification.

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