

Analysis Results for North Central Illinois
LANDSAT Scene CIA; August 3, 1975

I. OBJECTIVES

The major goal of this analysis was to make crop acreage estimates for corn and soybeans in CIA. These estimates were to be based on LANDSAT data as an auxiliary variable using a regression type estimator. The area to be considered was seven counties in North Central Illinois: Boone, Bureau, Dekalb, Lee, McHenry, Ogle, and Winnebago.

The area originally to be considered (scene C1) had to be reduced to the seven counties (CIA) because of cloud cover problems in the south and east sections of C1. The part with cloud cover was analyzed on another scene with a different date. The estimates for the seven individual counties were computed along with their relative sampling errors and also for the seven county aggregate area. Four of the county estimates were used along with county estimates from other scenes to make an estimate for the Northwest Crop Reporting district. This estimate can be directly compared to the JES estimate for that area and year. Although the precision of the individual estimates cannot be compared directly to JES estimates; the RE_2 relative efficiency in the tables is a measure of the gain, in terms of lower variance, of the regression estimate over the JES direct expansion type estimate.

II. DESIGNING AND EVALUATING CLASSIFIERS

The classification categories were determined from the "Not Background" packed file. Any crop was included with more than (or close to) 200 pixels. These ten crop types (or covers) were then clustered and fourteen categories were determined, with waste, oats, water, and cropland pasture having two categories each and with wheat and oat stubble combined to one category.

Two levels of prior probabilities were studied; priors proportional and expanded reported acres (PER) and Equal Priors (EP). The PER priors were obtained from the \emptyset pooling of the seven counties with the Direct Expansion estimator.

Two methods were considered to allocate the data from JES segments for training and testing purposes. The resubstitution approach where the "Not Background" file was used to train and to test is one method. The other method used was a 50% sample partition of fields for training and the "Not Background" file for testing.

Three different strata poolings were tried for picking a classifier:

- 1) the \emptyset pooling with $\emptyset \leftarrow 11, 12, 20, 31, 32, 33, 40, 61$;
- 2) the 10-50 pooling
with $10 \leftarrow 11, 12$
and $50 \leftarrow 20, 31, 32, 33, 40, 61$;
- 3) the 11-12-20-30 pooling
with 11, 12, 20 separate
and $30 \leftarrow 31, 32, 33, 40, 61$.

With the 11-12-20-30 pooling, strata 20 had to be "swiss cheesed". This was a method of estimating a strata with no ground data for a given scene from the direct expansion estimator.

The best classifier combination was felt to be the 11-12-20-30/EP/FLDS (11-12-20-30 pooling, equal priors, and a 50% sample partition). This classifier had the best corn RE_2 (6.30) and an acceptable soybean RE_2 (2.76). The optimum soybean classifier combination (judged by $RE_2=3.83$) was the \emptyset /PER/FLDS (\emptyset pooling, PER priors, and 50% sample partition of fields). The \emptyset /PER/FLDS was also optimum for wasteland. For the two major crops considered, the 50% sample partition of fields was always a better classifier (over all poolings) than the whole sample NB file (or Not Background). The PER (priors) classifiers were optimum for soybeans while the EP classifiers were optimum for corn training. The worst

classifier seemed to be the \emptyset /EP/NB. Note here that the NB/PER table file had the optimum percent correct for overall cover types.

III. CLASSIFY AND AGGREGATE

After deciding on a classifier, the statistics file for the FLDS/EP table file was retrieved from BBN archive and inverted, then sent to ILLIAC IV via the FTP command. Then "window-files" for the seven counties wholly contained in CIA were pulled from a LANDSAT tape and also filed. The strata network file was used to generate "mask files" for each county. The masks were then FTP-ed to ILLIAC IV for aggregation processing by county. Each county was then processed individually at ILLIAC IV with the classify and aggregate command in EDITOR. The seven resulting aggregate files were FTP-ed back to BBN and summed to get an aggregate file for the seven county area.

IV. LARGE AREA ESTIMATES

Using the estimator file from the 11-12-20-30 pooling and the FLDS/EP classifier file, the large scale estimate command in EDITOR was entered for the two cover types of concern (corn, soybeans). Thus for both covers, a county estimate was generated along with a total area estimate. For corn, the total area estimate had a CV of 2.9 percent, with individual counties ranging from 10.6 - 12.8. The LANDSAT regression estimate for corn was .4 of a percent above the preliminary SSO county estimate. Note however the regression estimate was of standing acres and acreage in field while the SSO estimates harvested acres. The soybeans estimate came out with an 8.2 percent CV, with the individual counties ranging from 30.2 to 51.8 percent. However, this was not the optimal classifier for soybeans. The regression estimate was 3.7 percent greater than the SSO county estimates for the seven county area.

Up to this point the estimates were calculated using the 11-12-20-30 pooling where strata 20 was estimated by the "swiss cheese" prorating of the direct expansion estimate. Another approach considered was to use the 11-12-50 pooling

where strata 20 is pooled with 31, 32, 33, 40 and 61 to get strata 50. This would save the time used to compute the strata 20 estimate. It was found that the estimate changed less than .2 percent for either cover at the total area level. At the county level, the estimates changed about 1 percent with respect to the SSO estimate.

Another procedure that was explored was to use the 11-12-20-30 pooling for corn and the \emptyset pooling for soybeans in combination with the FLDS/EP classifier file. This was considered because although corn had a bad RE_2 for the \emptyset pooling soybeans had a better RE_2 than for the 11-12-20-30. This approach was discarded for soybeans because the individual county estimates for soybeans had larger CV's than with the 11-12-20-30 pooling even though the overall CV was slightly better for \emptyset pooling soybeans.

Following you will find tables for:

1. Large Area Estimates (Corn and Soybeans).
2. CIA Relative Efficiencies w.r.t. JES type Estimator (RE_2).
3. R^2 , RE_1 For CIA-TAB.14-GPS/FLDS/EP.
4. R^2 , RE_1 For CIA-TAB.14-GPS/FLDS/PER.
5. R^2 , RE_1 For CIA-TAB.14-GPS/NB/EP.
6. R^2 , RE_1 For CIA-TAB.14-GPS/NB/PER.
7. Northwest Crop Reporting District Results.

LARGE AREA ESTIMATES

	Harv. Acres SSO*	LANDSAT Estimate Standing Acres - CIA			Ratio CIA/SSO	Harv. Acres SSO*	LANDSAT Estimate Standing Acres - CIA			Ratio CIA/SSO	
		Estimate	Std Dev	% C.V.			Estimate	Std Dev	% C.V.		
CORN (11-12-20-30)						CORN (11-12-50)					
Boone	74,200	76,904	9,557	12.4	103.6	74,200	76,904	9,557	12.4	103.6	
Bureau	254,400	231,931	27,909	12.0	91.2	254,400	229,875	28,038	12.2	90.4	
Dehalb	195,800	182,741	23,368	12.8	93.3	195,800	182,741	23,668	12.8	93.3	
Lee	200,000	208,983	25,379	12.1	104.5	200,000	208,983	25,379	12.1	104.5	
McHenry	134,200	139,648	15,277	10.9	104.2	134,200	139,812	15,286	10.9	104.2	
Ogle	210,200	217,368	23,944	11.0	103.4	210,200	216,244	23,973	11.1	102.9	
Winnebago	106,900	122,957	13,015	10.6	115.0	106,900	122,957	13,016	10.6	115.0	
Total Area	1,175,700	1,180,531	33,675	2.9	100.4	1,175,700	1,177,514	33,934	2.9	100.2	
SOYBEANS (11-12-20-30)						SOYBEANS (11-12-50)					
Boone	40,000	29,365	13,748	46.8	73.4	40,000	29,365	13,748	46.8	73.4	
Bureau	118,700	132,582	40,104	30.2	111.7	118,700	134,991	40,120	29.7	113.7	
Dehalb	111,400	98,969	33,777	34.1	88.8	111,400	98,969	33,777	34.1	88.8	
Lee	112,000	110,808	36,507	32.9	98.9	112,000	110,808	36,507	32.9	98.9	
McHenry	35,000	49,750	20,002	40.2	142.1	35,000	49,750	20,002	40.2	142.1	
Ogle	61,800	68,188	34,197	50.2	110.3	61,800	66,913	34,201	51.1	108.3	
Winnebago	25,700	33,621	17,400	51.8	130.8	25,700	33,621	17,400	51.8	130.8	
Total Area	504,600	523,214	43,037	8.2	103.7	504,600	524,417	43,046	8.2	103.9	

* Preliminary 1975 County Estimates by Illinois SSO

CIA - Relative Efficiencies With Respect to JES Expansion Estimator**

(RE₂)

	11-12-20-30 pooling*				10-50 pooling				0 pooling			
Prior	PER	EP	PER	EP	PER	EP	PER	EP	PER	EP	PER	EP
Sampling	FLDS	FLDS	NB	NB	FLDS	FLDS	NB	NB	FLDS	FLDS	NB	NB
Corn	2.20	6.30	2.01	5.39	1.60	3.72	1.49	3.08	1.21	2.19	1.14	1.71
Soybeans	3.39	2.76	3.11	2.38	3.48	2.79	3.19	2.39	3.83	3.05	3.53	2.62
Waste	3.00	2.85	2.98	2.99	3.22	2.57	3.17	3.17	1.76	1.87	1.54	1.90

* with strat 20 being "swiss cheesed"

** Used 11-12-50 pooling for direct expansion since strata 20 had no segments in CIA.

Optimum for:	RE ₂	Classifier
Corn	6.30	11-12-20-30/FLDS/EP
Soybeans	3.83	0/FLDS/PER
Waste	3.22	0/FLDS/PER

Poolings

0 ← 11,12,20,31,32,33,40,61

10 ← 11,12

30 ← 31,32,33,40,61

50 ← 20,31,32,33,40,61

Optimum % Correct Overall

CIA-TAB.14-GPS/NB/PER

CIA-TAB GPS/NB/FLDS/EP

	10-50 pooling				11-12-30 pooling (str 20 deleted)					0 pooling			% Correct (42.7)
	R ²		Relative Efficiency		R ²			Relative Efficiency		R ²	Relative Efficiency		
	10	50	RE ₁	RE ₂	11	12	30	RE ₁ *	RE ₂	0	RE ₁	RE ₂	
Alfalfa	.0542	.0000	0.99		.2000	.5536	.0000	1.26		.0432	1.01		13.5
Corn	.7499	.6595	3.81	3.72	.8647	.7879	.6595	6.29	6.30	.7725	4.24	2.19	44.2
Waste	.1069	.9438	2.57	2.57	.1659	.4590	.9438	2.27	2.85	.8983	9.49	1.87	20.8
PPast	.3976	.0164	1.51		.8439	.0262	.0164	1.10		.3400	1.46		19.4
Oats	.4173	.2789	1.58		.4539	.0037	.2789	1.50		.3842	1.57		39.9
Soybeans	.6711	.9801	3.03	2.79	.6636	.2974	.9801	2.72	2.76	.7111	3.34	3.05	61.6
Woods	.0107	.4300	0.97	0.85	.0077	.4951	.4300	1.07	1.08	.0443	1.01	1.02	54.0
Water	.0030		0.96			.1650				.0024	0.97		6.8
CPast	.2418		1.26		.3215	.0012		1.16		.1515	1.14		51.4
Stubble	.2436		1.27		.2657	.0821		1.27		.0011	0.97		36.0

42.7

	11-12-50 Pooling				
	R ²			Relative Efficiency	
	11	12	50	RE ₁	RE ₂
Corn	.8647	.7879	.6595	6.26	6.26
Soybeans	.6636	.2974	.9801	2.76	2.76

$$RE_2 = \frac{VAR(Dir Exp-11-12-50)}{VAR(Regr-current pooling)}$$

* Swiss Cheese.

CIA-TAB. GPS/NB/FLDS/PER

	10-50 pooling				11-12-30 pooling (str 20 deleted)					0 pooling			% Correct (62.8 overall)
	R ²		Relative Efficiency		R ²			Relative Efficiency		R ²	Relative Efficiency		
	10	50	RE ₁	RE ₂	11	12	30	RE ₁ *	RE ₂	0	RE ₁	RE ₂	
Alfalfa	.0839	.0075	1.02		.2906	.7206	.0075	1.55		.0612	1.03		9.4
Corn	.4120	.7484	1.64	1.60	.5790	.6016	.7484	2.19	(2.20)	.5880	2.34	1.21	86.9
Waste	.2102	.9906	3.22	3.22	.2258	.0610	.9906	2.39	(3.00)	.8924	8.98	1.76	46.1
PPast	.4662	.0234	1.63		.8395	.1475	.0234	1.23		.3735	1.54		7.7
Oats	.1560	.1201	1.11		.1620	.0055	.1201	1.06		.1336	1.11		22.6
Soybeans	.7373	.9771	3.78	3.48	.7411	.1468	.9771	3.35	(3.39)	.7699	4.20	3.83	67.8
Woods													0.0
Water										.0021	0.97		4.6
CPast	.5879		2.33		.6613	.8936		3.14		.5793	2.30		17.5
Stubble	.3723		1.53		.4178	.1420		1.59		.1441	1.13		15.0

62.8

* Swiss Cheese.

CIA-TAB GPS/NB/FP

	10-50 pooling				11-12-30 pooling (str 20 deleted)					0 pooling			% Correct 41.1
	R ²		Relative Efficiency		R ²			Relative Efficiency		R ²	Relative Efficiency		
	10	50	RE ₁	RE ₂ *	11	12	30	RE ₁	RE ₂ *	0	RE ₁	RE ₂ *	
Alfalfa	.1052	.1627	1.06		.3413	.4237	.1627	1.29		.1103	1.09		12.1
Corn	.6975	.5886	3.15	3.08	.8390	.7730	.5886	5.38	(5.39)	.7078	3.30	1.71	40.7
Waste	.1349	.9484	2.67	3.17	.1988	.4959	.9484	2.38	(2.99)	.9002	9.68	1.90	20.3
PPast	.3704	.0002	1.45		.8288	.0509	.0002	1.11		.3080	1.40		18.6
Oats	.4671	.5671	1.79		.5251	.0013	.5671	1.73		.4769	1.85		44.9
Soybeans	.6170	.9633	2.59	2.39	.6080	.2369	.9633	2.35	(2.38)	.6644	2.88	2.62	60.5
Woods	.0042	.1440	0.96	0.84	.0284	.5797	.1440	1.15	(1.15)	.0332	1.00	1.00	59.9
Water	.0030		0.96			.1650				.0024	0.97		6.8
CPast	.2704		1.31		.3604	.0106		1.21		.1936	1.20		59.9
Stubble	.3461		1.47		.3991	.1849		1.55		.0016	0.97		35.6

41.1

* RE₂ = Relative efficiency with respect to 11-12-50 pooling direct expansion estimator for all counties wholly contained.

CIA-TAB. 14-GPS/NB/PER

	10-50 pooling				11-12-30 pooling (str 20 deleted)					0 pooling			% Correct
	R ²		Relative Efficiency		R ²			Relative Efficiency		R ²	Relative Efficiency		
	10	50	RE ₁	RE ₂ *	11	12	30	RE ₁	RE ₂ *	0	RE ₁	RE ₂ *	
Alfalfa	.0449	.2786	1.01		.1748	.1435	.2786	0.97		.1103	1.09		6.1
Corn	.3697	.7830	1.53	1.49	.5329	.6098	.7830	2.01	(2.01)	.7078	3.30	1.14	87.4
Waste	.1900	.9940	3.17	3.17	.2001	.1245	.9940	2.38	(2.98)	.9002	9.68	1.54	48.9
PPast	.3666	.0625	1.45		.8306	.0204	.0625	1.09		.3080	1.40		2.0
Oats	.1542	.0923	1.10		.1623	.1111	.0923	1.07		.4769	1.85		22.1
Soybeans	.7135	.9647	3.46	3.19	.7156	.1199	.9647	3.07	(3.11)	.6644	2.88	3.53	68.1
Woods										.0332	1.00		0.0
Water										.0024	0.97		4.6
CPast	.6281		2.58		.7020	.7281		3.02		.1936	1.20		15.4
Stubble	.1762		1.16		.1963	.2016		1.17		.0016	0.97		7.3

62.8

$$*RE_2 = \frac{\text{VAR (Dir Exp-11-12-50)}}{\text{VAR (Regr-current pooling)}}$$

Northwest Crop Reporting District

	Analysis Pass	Corn					Soybeans				
		Estimate	Std Dev	CV	SSO County Estimate	Ratio to SSO CE	Estimate	Std Dev	CV	SSO County Estimate	Ratio to SSO CE
Bureau	CIA	229,875	28,038	12.2	254,400	90.4	134,991	40,120	29.7	118,700	113.7
Carroll	W123	126,517	22,199	17.5	131,100	96.5	57,184	16,923	29.6	11,000	519.9
Henry	W123	276,764	47,499	17.2	262,200	105.6	79,381	36,957	46.6	72,500	109.5
JoDaviess	W123	108,313	36,967	34.1	73,800	146.8	27,116	25,544	94.2	7,000	387.4
Lee	CIA	208,983	25,379	12.1	200,000	104.5	110,808	36,507	32.9	112,000	98.9
Mercer	W123	139,799	26,186	18.7	152,400	91.7	43,917	19,071	43.4	40,600	108.2
Ogle	CIA	216,244	23,973	11.1	210,200	102.9	66,913	34,201	51.1	61,800	108.3
Putnam	C12	38,733	10,745	27.7	45,000	86.1	23,494	7,657	32.6	20,200	116.3
Rock Island	W123	107,002	20,043	18.7	75,700	141.4	27,507	14,490	52.7	23,600	116.6
Stephenson	W123	172,057	31,978	18.6	160,400	107.3	30,584	25,015	81.8	21,000	145.6
Whiteside	W123	242,826	39,335	16.2	217,300	111.7	62,410	30,566	49.0	63,700	98.0
Winnebago	CIA	122,957	13,016	10.6	106,900	115.0	33,621	17,400	51.8	25,700	130.8
Northwest	W123, CIA, C12	1,990,071	215,289	10.8	1,889,400	105.3	697,927	195,794	28.1	577,800	120.8
Northwest	Dir Exp	2,079,688	109,213	5.1	1,889,400	110.1	540,003	75,640	13.4	577,800	93.5