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ANALYSIS OF FIELD SIZE DISTRIBUTIONS, LACIE TEST SITES 5029, 5033, AND 5039, ANHWEI PROVINCE, PEOPLE'S REPUBLIC OF CHINA
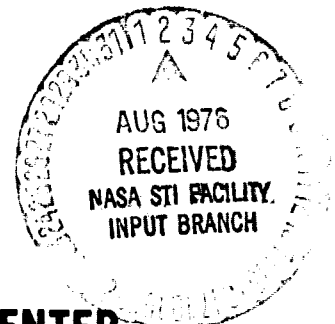
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GSFC —— **GODDARD SPACE FLIGHT CENTER** ——
GREENBELT, MARYLAND

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ABSTRACT

A study was made of the field size distributions for LACIE test sites 5029, 5033, and 5039, People's Republic of China. Field lengths and widths were measured from Landsat imagery and field area was statistically modeled by the procedures enumerated in a previous study (Podwysocki, 1976). Field size parameters have log-normal or Poisson frequency distributions. These were normalized to the Gaussian distribution and theoretical population curves were made. When compared to fields in other areas of the same country measured in the previous study, field lengths and widths in the three LACIE test sites were 2 to 3 times smaller and areas were smaller by an order of magnitude.

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ANALYSIS OF FIELD SIZE DISTRIBUTIONS, LACIE TEST SITES 5029, 5033, AND 5039, ANHWEI PROVINCE, PEOPLE'S REPUBLIC OF CHINA

INTRODUCTION

Estimates were made of field size distributions for a total of nine primarily wheat growing areas located within six countries (Podwysocki, 1976), including two in the People's Republic of China. The areas examined were randomly chosen from data compiled by Ecosystems, Inc. (NASA Contract #NAS5-22837). Because of the short time in which the results were required, it was impossible to assure that the samples would be representative of each of the countries. A number of areas within each country would have to be sampled in order to assure such an accurate inventory of field sizes (Podwysocki, 1976). Discussions with personnel at NASA Headquarters and Johnson Space Center indicated that the previous data presented for the People's Republic of China (labeled PRC 1 & 2 in the above mentioned report), indicated fields much larger in size than those encountered in the LACIE project study areas for this country. In order to determine the range of field sizes encountered in the LACIE experiment, three test sites were suggested (L. C. Wade, JSC, pers. comm., 1976) for analysis, #5029, 5033, and 5039 in Anhwei Province.

METHODS

Methodology is the same as reported by Podwysocki (1976). Enhanced color images at an approximate scale of 1:70,000 were created from Landsat CCTs and sampling was done on a 0.5 x 1 km grid. Because of the small size of the fields, in many instances less than 1 pixel in size, measurement of the exact boundaries of the fields was difficult. Therefore, a subjective decision was made for the assumed boundary based upon the intensity of a color change (i. e., two "significantly" different levels of brown would be treated as two fields). Otherwise, the data were treated exactly the same as in the previous effort.

DISCUSSION

Tables 1 through 3 summarize the results for the three study areas. In all three cases, the data more closely approximate a Gaussian distribution after transformation by $\log_2$. A $\log_{10}$ transform was also applied and results are similar, but in order to maintain consistency between the two studies, the former transformation was retained. Because the distributions approached normality, the mean and standard deviations can be used as population estimators. Figures 1 through 3

1

represent the cumulative frequency distributions for the nine test areas of the previous paper as well as the three new ones. The new study areas differ considerably from the earlier group of areas studied (PRC 1 & 2), being smaller in length and width by a factor of 2 to 3 and by an order of magnitude in area. This supports one of the recommendations in the prior paper which suggested that more areas within a grain producing country and its individual agricultural provinces should be analyzed in order to determine a more accurate estimation of the total pattern.

In order to determine the average field width associated with a given field area, regression analysis was performed on the untransformed width and area parameters. Field width (by definition, the shorter of the two measurements) determines the minimum resolution required to inventory a given portion of a crop. Table 4 contains correlation and the regression coefficients for the LACIE sites. The regression coefficients are significant at $P_{.05}$, indicating that the data is well correlated. Table 5 contains the resultant field widths correlated with total production for each of the study areas. When compared to the original study (PRC 1 & 2), these data show a threefold decrease in field width required to inventory a given percentage of the crop area.

CONCLUSIONS

Analysis of additional imagery in the People's Republic of China for estimation of field size indicates that fields in the new study area are 2 to 3 times smaller in length and width, and an order of magnitude smaller in area when compared to the original study. This supports the previously stated suggestion that additional studies are required in order to accurately determine the range of field sizes which occur within individual agricultural provinces in the major grain producing countries.

REFERENCE

M. H. Podwysocki. "An Estimate of Field Size Distributions for Selected Sites in the Major Grain Producing Countries." NASA/GSFC X-923-76-93, April 1976, 34 pp.
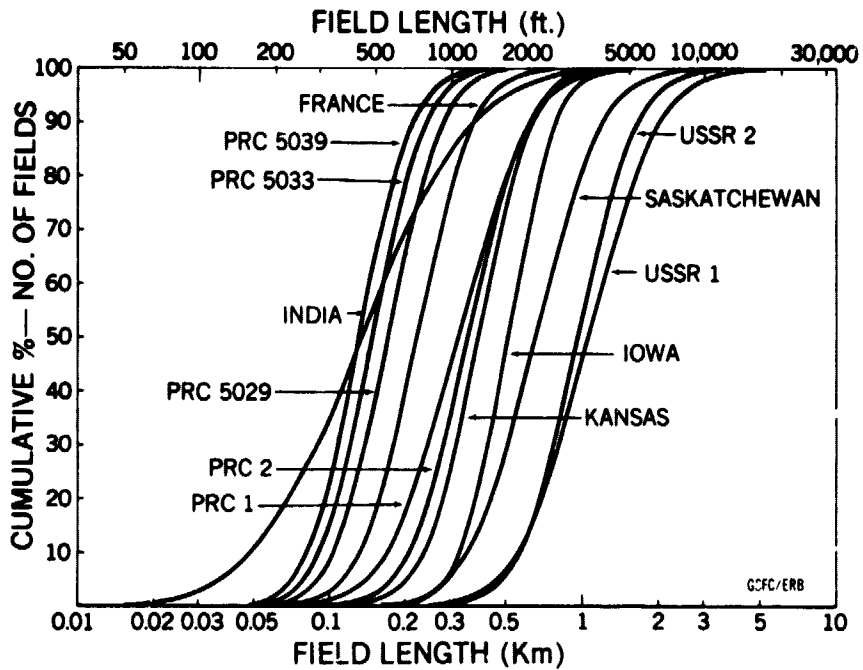
Figure 1. Cumulative Frequency Distribution (in %) of
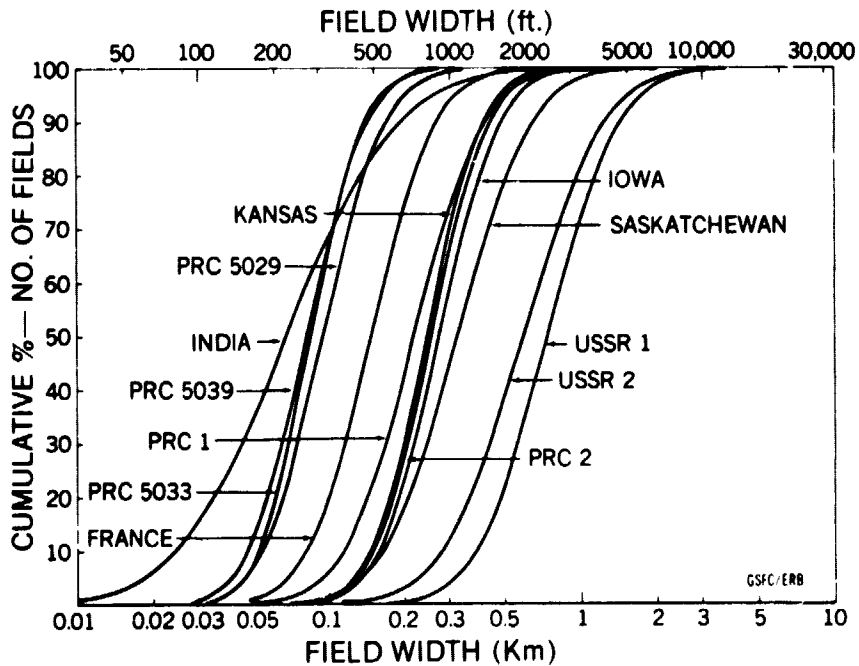Field Length vs. Total Number of Fields

Figure 2. Cumulative Frequency Distribution (in %) of
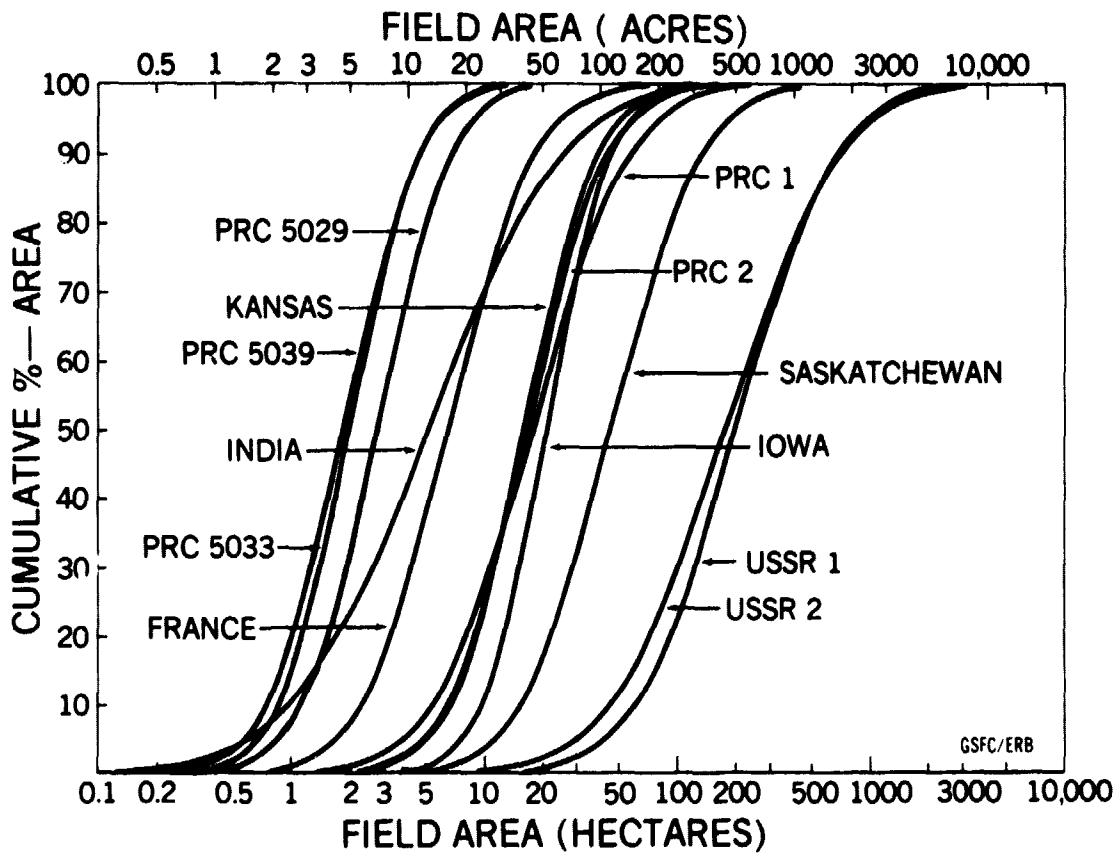Field Width vs. Total Number of Fields

Figure 3. Cumulative Frequency Distribution (in %) of Field Area vs. Total Cumulative Area

Table 1

Population Estimators
PRC 5029
SAMPLE SIZE = 138

	Raw Data			Transformed Data		
	Length[1]	Width[1]	Area[2]	Length[3]	Width[3]	Area[4]
Mean	.19	.11	2.31	-2.47	-3.30	.88
Std. Dev.	.08	.05	1.53	.55	.64	1.02
Skewness	1.35**	.62**	1.19**	$-$ .15^{NS}	$-$ .37*	$-$ .32*
Kurtosis	7.41**	3.21^{NS}	4.26**	3.13^{NS}	2.67^{NS}	2.53^{NS}
Prob. χ^2	.11^{NS}	.02*	<.0001**	.66^{NS}	.12^{NS}	.04*
Confidence	4	4	0	8	7	5

^{NS} Nonsignificant
*Significant at $P_{.05}$
**Significant at $P_{.01}$

[1] Mean & Std. Dev. in Km
[2] Mean & Std. Dev. in Hectares
[3] Same as #1, but data transformed as below
[4] Same as #2, but data transformed as below

$$Y = \log_2 x$$
where   X = original value and
           Y = transformed value

Table 2

Population Estimators
PRC 5033
SAMPLE SIZE = 92

	Raw Data			Transformed Data		
	Length[1]	Width[1]	Area[2]	Length[3]	Width[3]	Area[4]
Mean	.17	.097	1.72	-2.67	-3.47	.51
Std. Dev.	.06	.036	1.06	.54	.55	.95
Skewness	.75**	.80**	1.25**	- .23[NS]	- .32[NS]	- .52*
Kurtosis	3.49[NS]	3.68[NS]	4.67**	2.90[NS]	3.28[NS]	3.53[NS]
Prob. χ^2	.22[NS]	.03*	.04*	.93[NS]	.21[NS]	.75
Confidence	6	4	2	8	8	7

[NS] Nonsignificant
 *Significant at $P_{.05}$
**Significant at $P_{.01}$

[1] Mean & Std. Dev. in Km
[2] Mean & Std. Dev. in Hectares
[3] Same as #1, but data transformed as below
[4] Same as #2, but data transformed as below

$$Y = \log_2 x$$
where x = original value and
Y = transformed value

Table 3

Population Estimators
PRC 5039
SAMPLE SIZE = 191

	Raw Data			Transformed Data		
	Length[1]	Width[1]	Area[2]	Length[3]	Width[3]	Area[4]
Mean	.15	.095	1.56	-2.83	-3.52	.29
Std. Dev.	.06	.040	1.19	.54	.62	1.03
Skewness	1.12**	.91**	2.25**	- .15^{NS}	- .44**	- .16^{NS}
Kurtosis	5.48**	4.20**	10.36**	3.01^{NS}	3.53^{NS}	2.91^{NS}
Prob. χ^2	.06^{NS}	.10^{NS}	<.0001**	.53^{NS}	.77^{NS}	.31^{NS}
Confidence	4	4	0	8	6	8

^{NS} Nonsignificant
 *Significant at $P_{.05}$
**Significant at $P_{.01}$

[1] Mean & Std. Dev. in Km
[2] Mean & Std. Dev. in Hectares
[3] Same as #1, but data transformed as below
[4] Same as #2, but data transformed as below

$$Y = \log_2 x$$

where X = original value and
        Y = transformed value

Table 4

Results of Linear Regression Analysis for Field Area vs. Width

Study Area	Correlation Coefficient (R)	Coefficients	
		A	B
PRC 5029	.861	28.2989	-0.85
PRC 5033	.840	24.7321	-0.67
PRC 5039	.891	26.6616	-0.98

To determine the average width association for a given field size, use the following general formula:

Field width (in Km) $= \dfrac{X-B}{A}$ where A and B are the coefficients listed above and X is the field size (in hectares) as read off the % cumulative area vs. area graphs (Fig. 3).

Table 5

Examples of Related Field Areas and Widths as Determined from Regression Analysis

Study Area	50%[1]		90%[1]	
	Area[2]	Field Widths[3]	Area[2]	Field Widths[3]
PRC 5029	2.83	.130	1.16	.071
PRC 5033	2.06	.110	.87	.062
PRC 5039	1.90	.108	.74	.065

[1] Percentage of total production to be inventoried (see text).
[2] Denotes the minimum field size (in hectares) associated with the given percentage of the total production.
[3] Denotes the average minimum width of fields (in Km) associated with given percentage of the production.