

CR-13735-3

214  
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QUARTERLY INFORMAL PROGRESS REPORT

"SYNTHESES AND ANALYSES OF EARTH RESOURCES  
TECHNOLOGY SATELLITE PROGRAM (ERTS) DATA"

FOR

NASA Headquarters  
Washington, D.C. 20546  
Attn: Office of Applications  
Code: E

(E74-10427) SYNTHESES AND ANALYSES OF  
EARTH RESOURCES TECHNOLOGY SATELLITE  
(ERTS) PROGRAM DATA Quarterly Informal  
Progress Report (Ecosystems International,  
Inc.) 37 p HC \$5.00 CSCL 02C

N74-19957

63/13 00427  
Unclas

PREPARED BY

ECOSYSTEMS INTERNATIONAL, INC.  
Post Office Box 225  
Gambrills, Maryland 21054

April 5, 1974



VALUE OF REMOTE SENSING AGRICULTURAL CROP FORECASTING

PRESENTATION TO

BENEFIT/COST TASK FORCE

22 MARCH 1974

ECOSYSTEMS INTERNATIONAL, INC.

Post Office Box 225

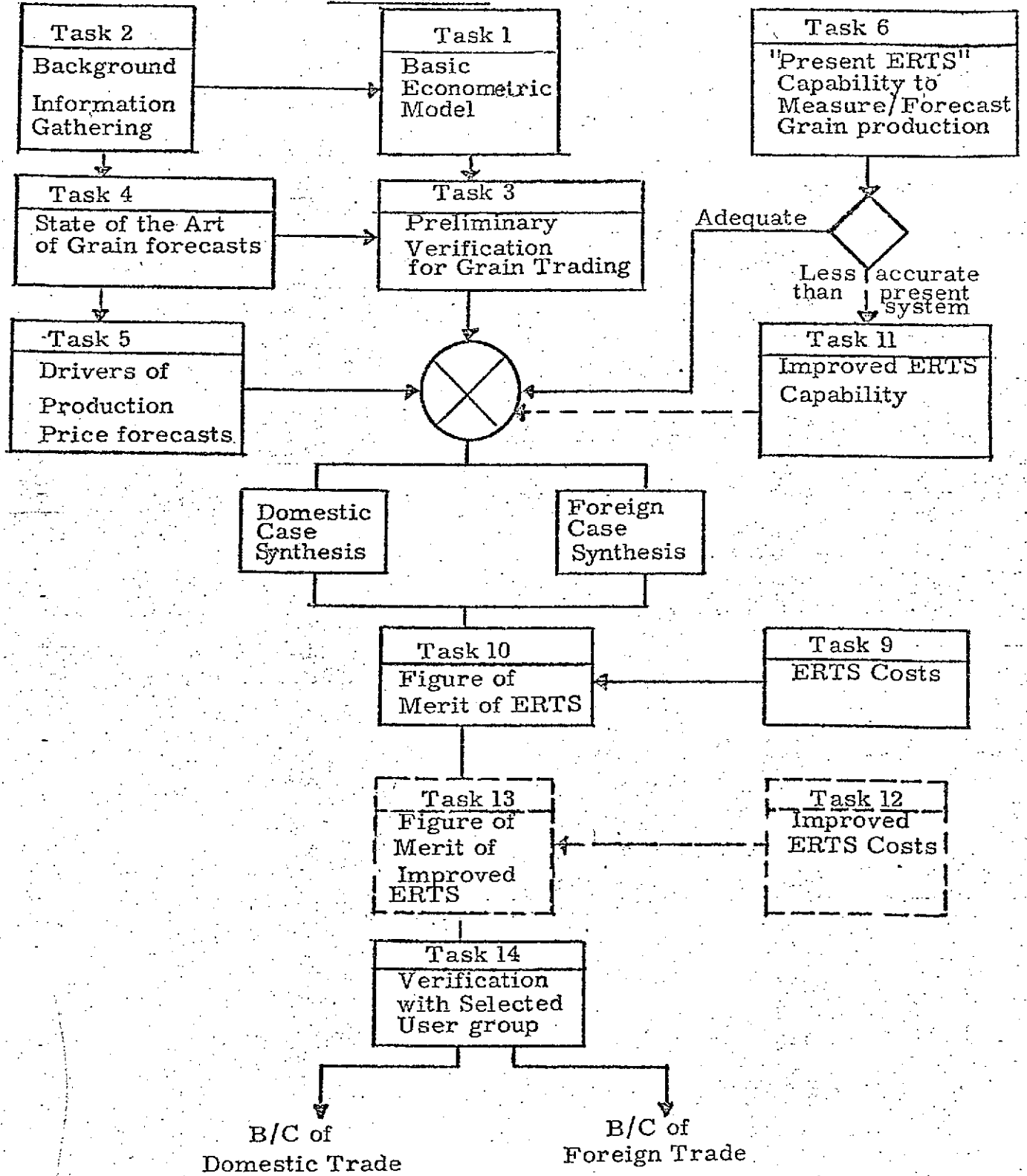
Gambrills, Maryland 21054

(301) 987-4976

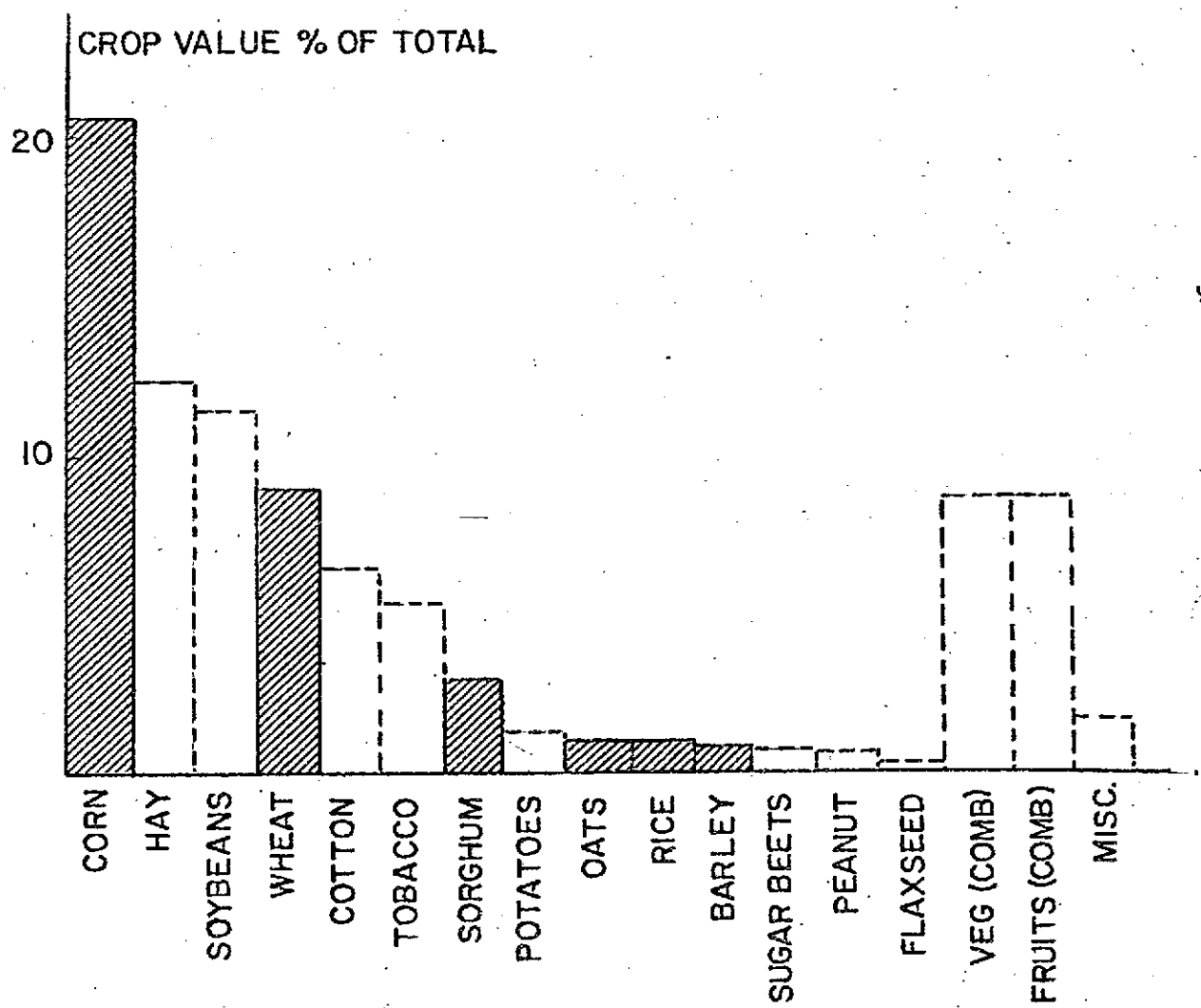
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# AGRICULTURAL COMMODITY FORECASTING

## WORK FLOW

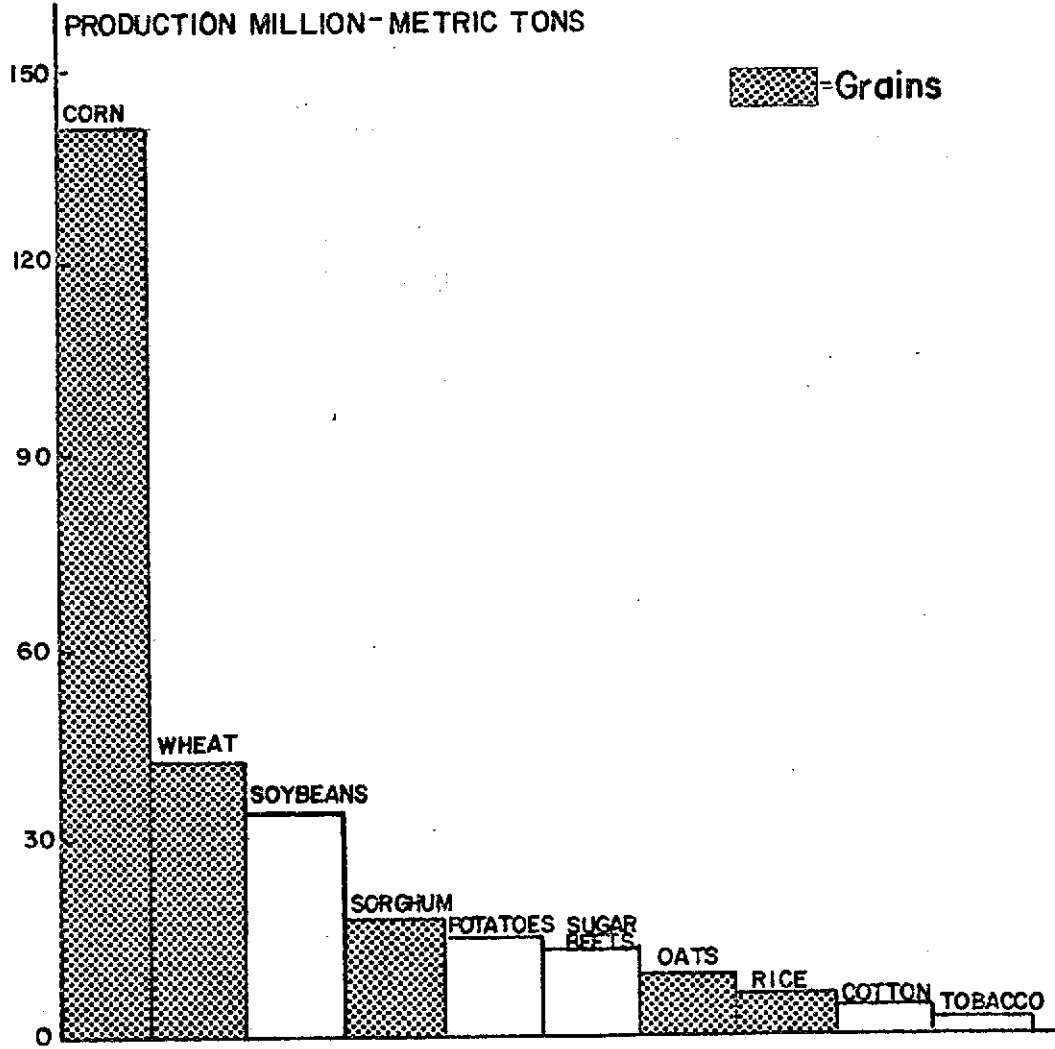


# RELATIVE VALUE OF U.S. CROPS

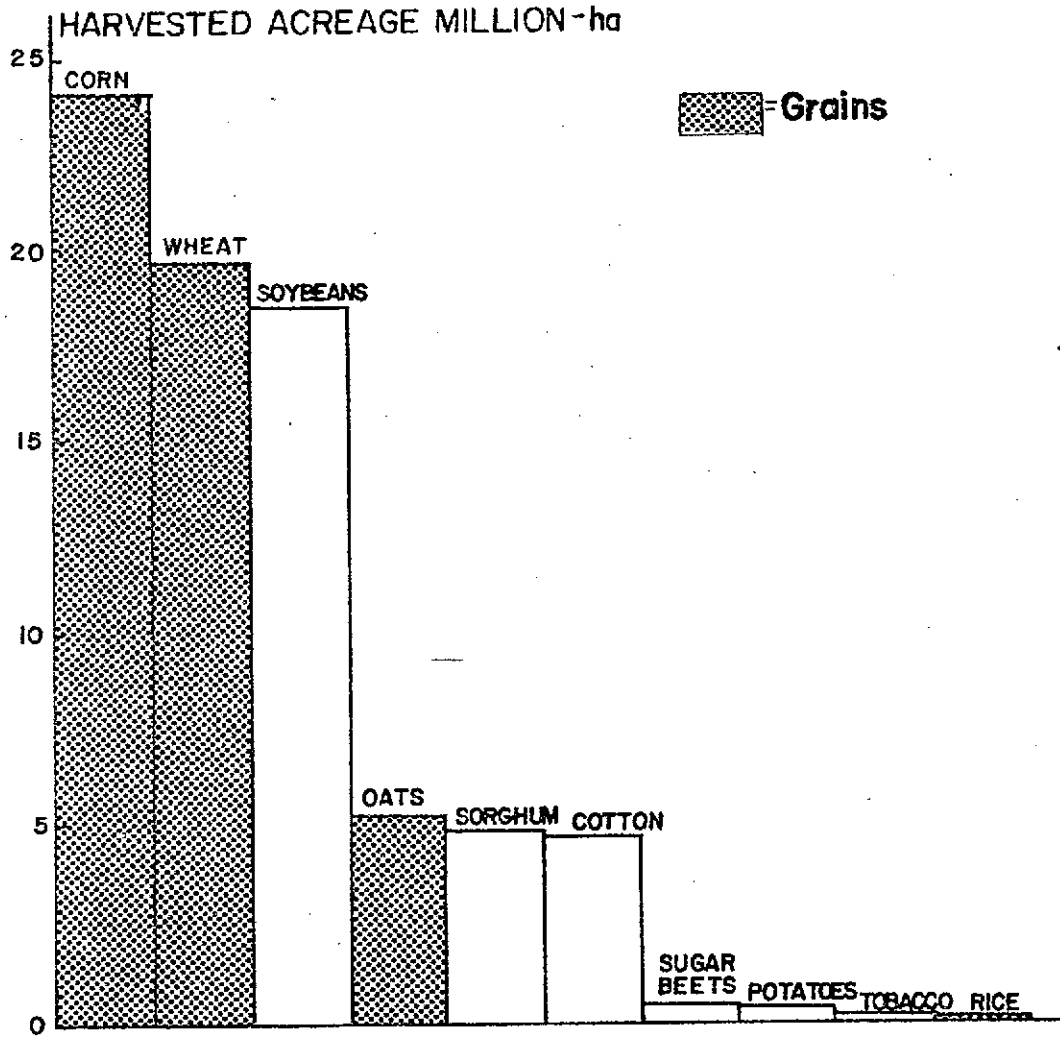


1

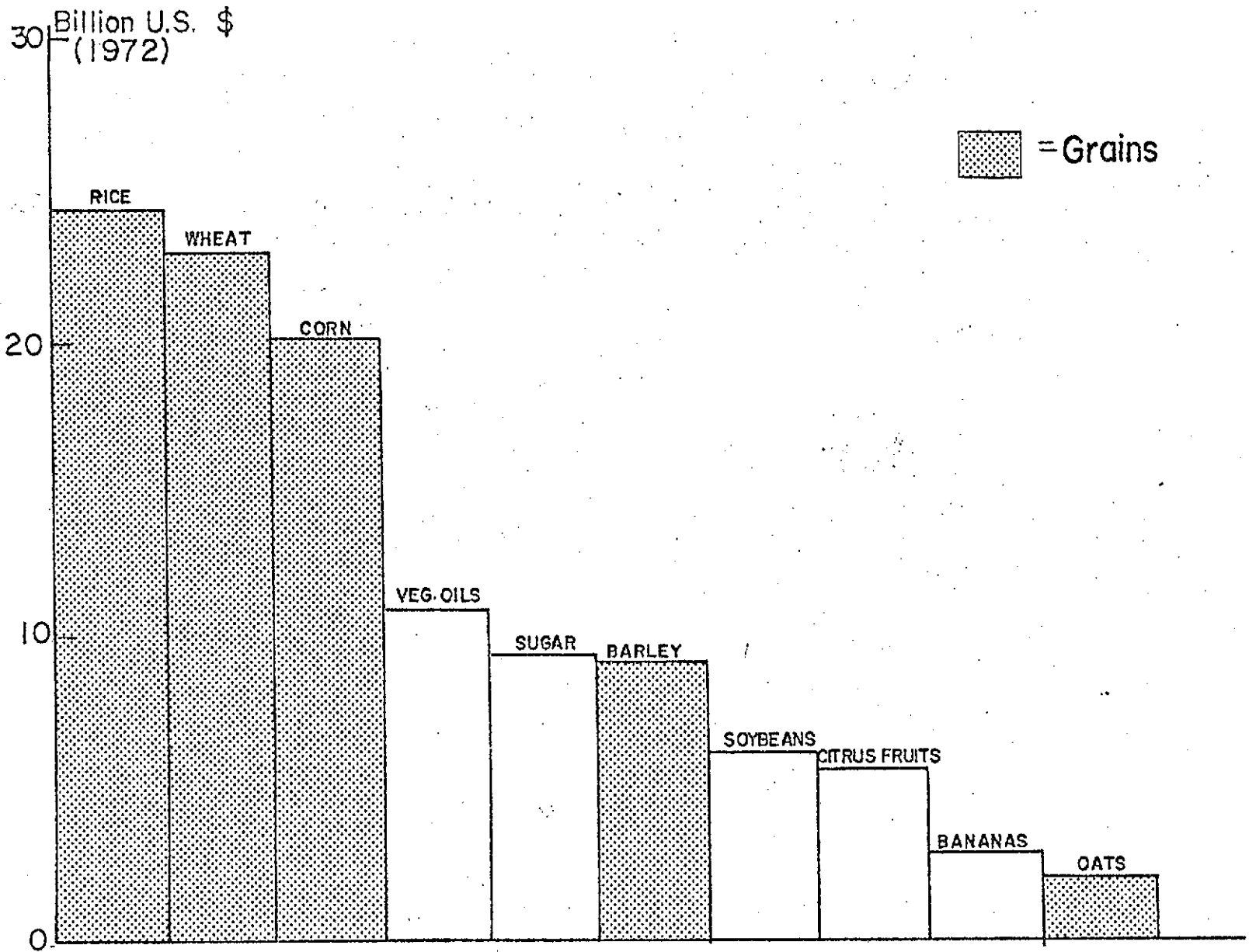
# UNITED STATES PRINCIPAL CROPS-1972



# UNITED STATES PRINCIPAL CROPS 1972

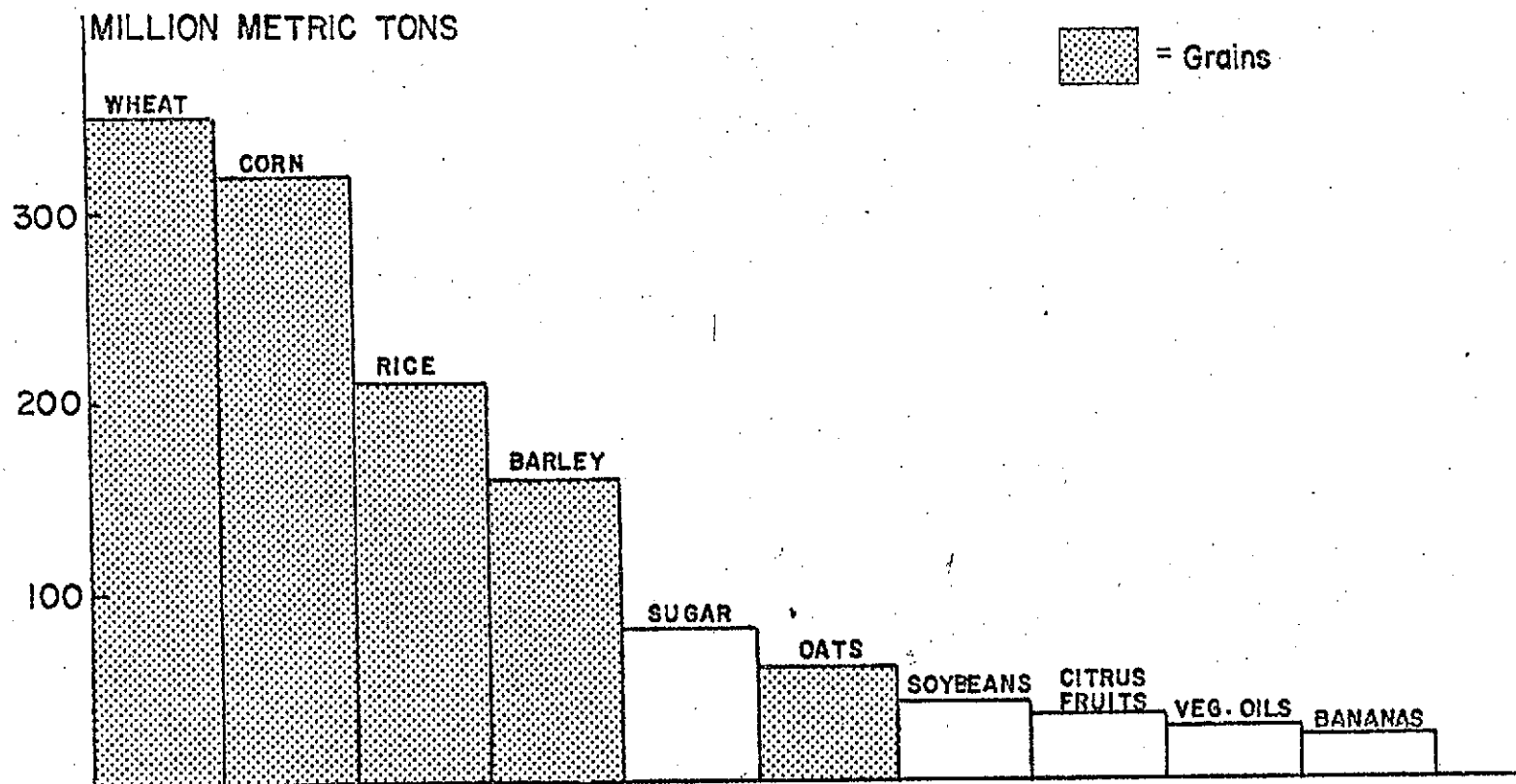


# TOTAL WORLD STAPLE CROP VALUE (1972) AT EXPORT PRICES

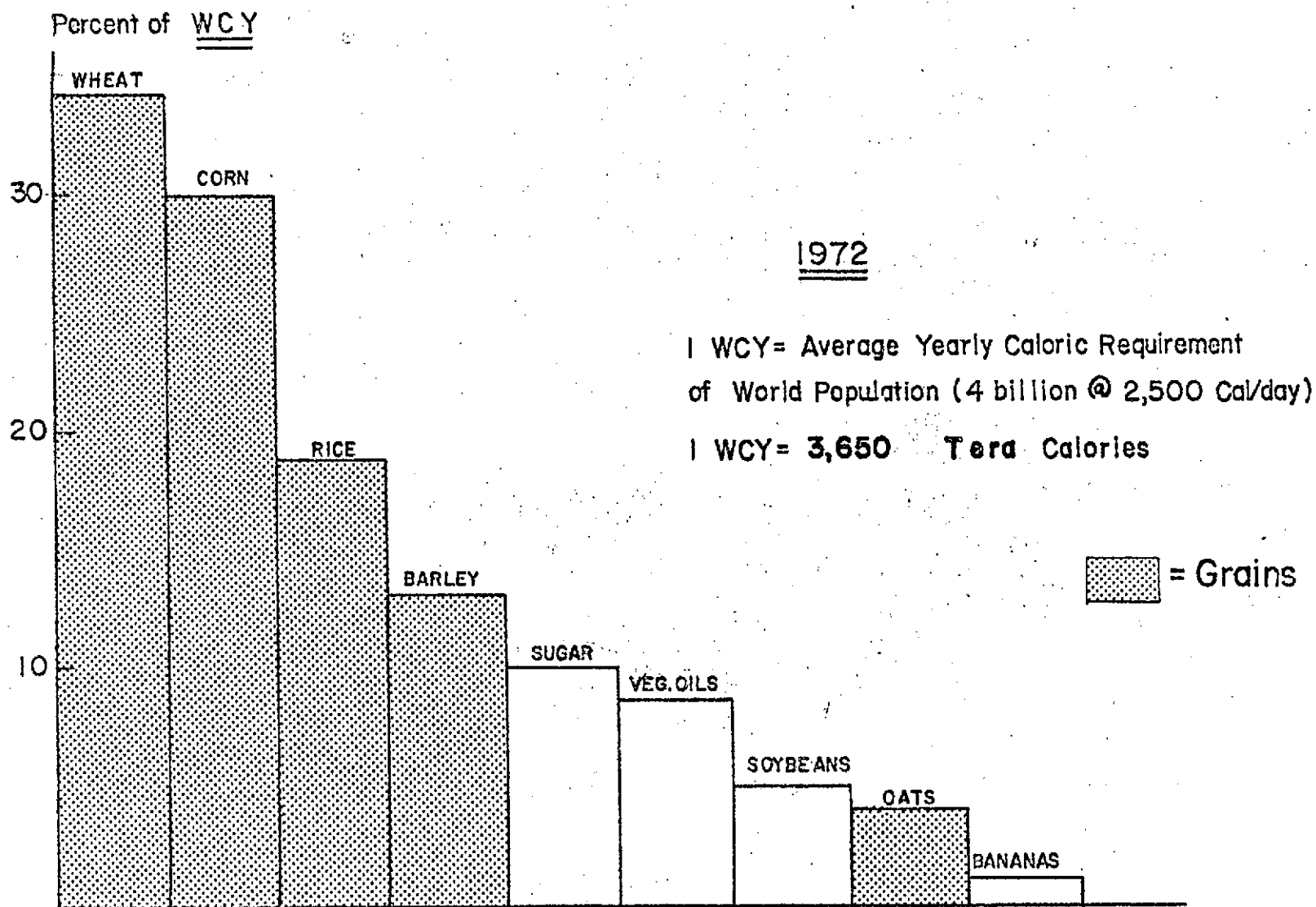


# WORLD STAPLE CROP PRODUCTION

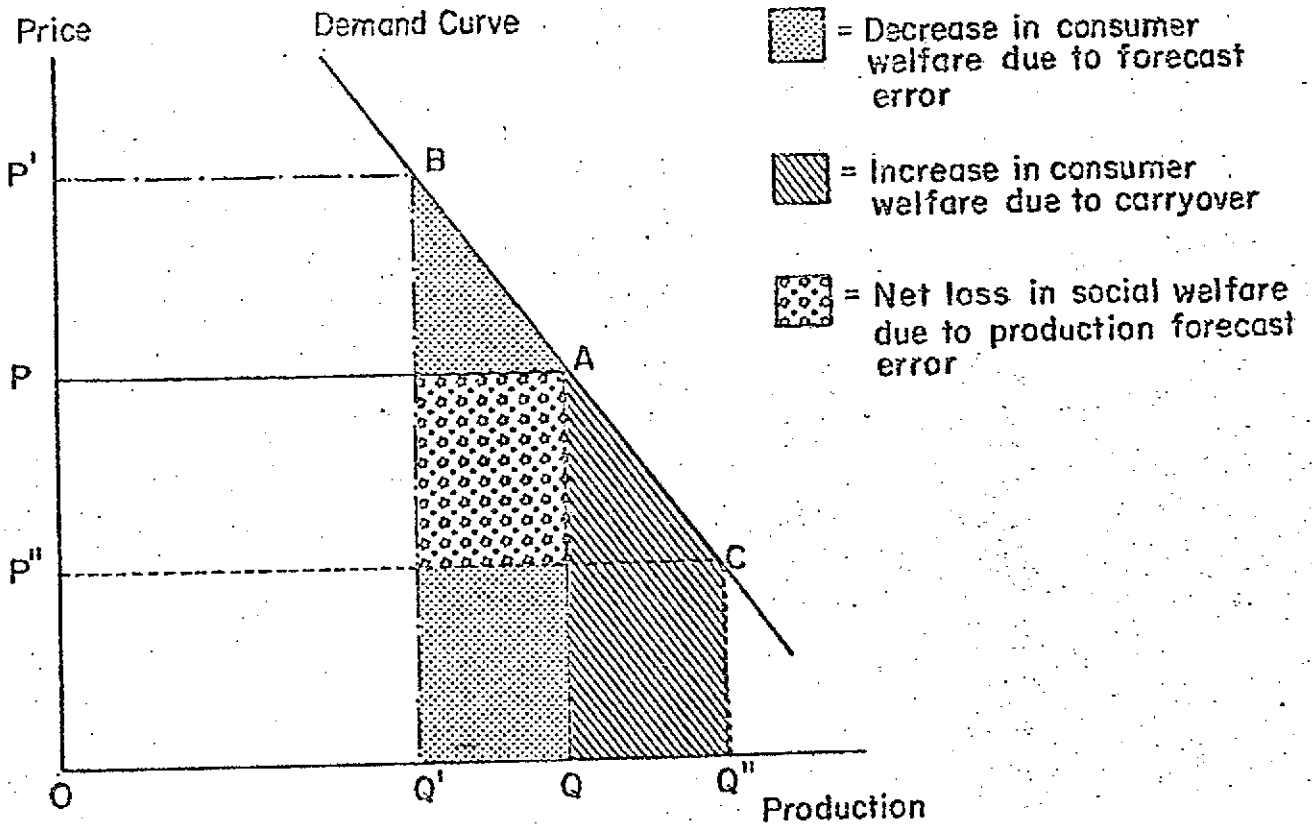
(1972)







CALORIC CONTENT OF WORLD STAPLE CROPS



$OQ$  = True Production

$OP$  = Price which would correspond to  $OQ$

$OQ'$  = Forecasted Production

$OP'$  = Price corresponding to estimated production  $OQ'$

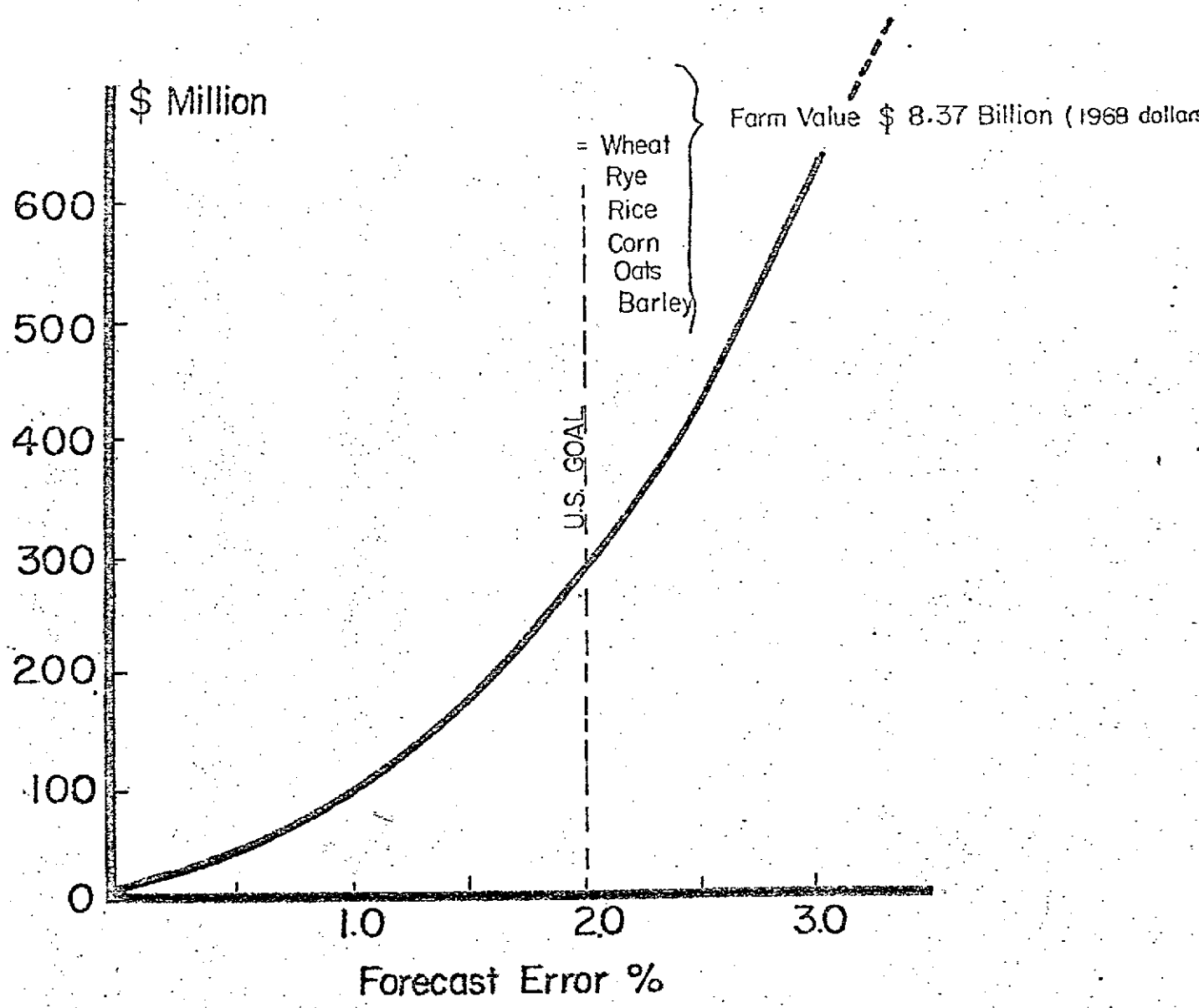
$QQ''$  = Quantity carried over to next year

$OP''$  = Price corresponding to next period production  $OQ$  plus stock carryover  $OQ''$

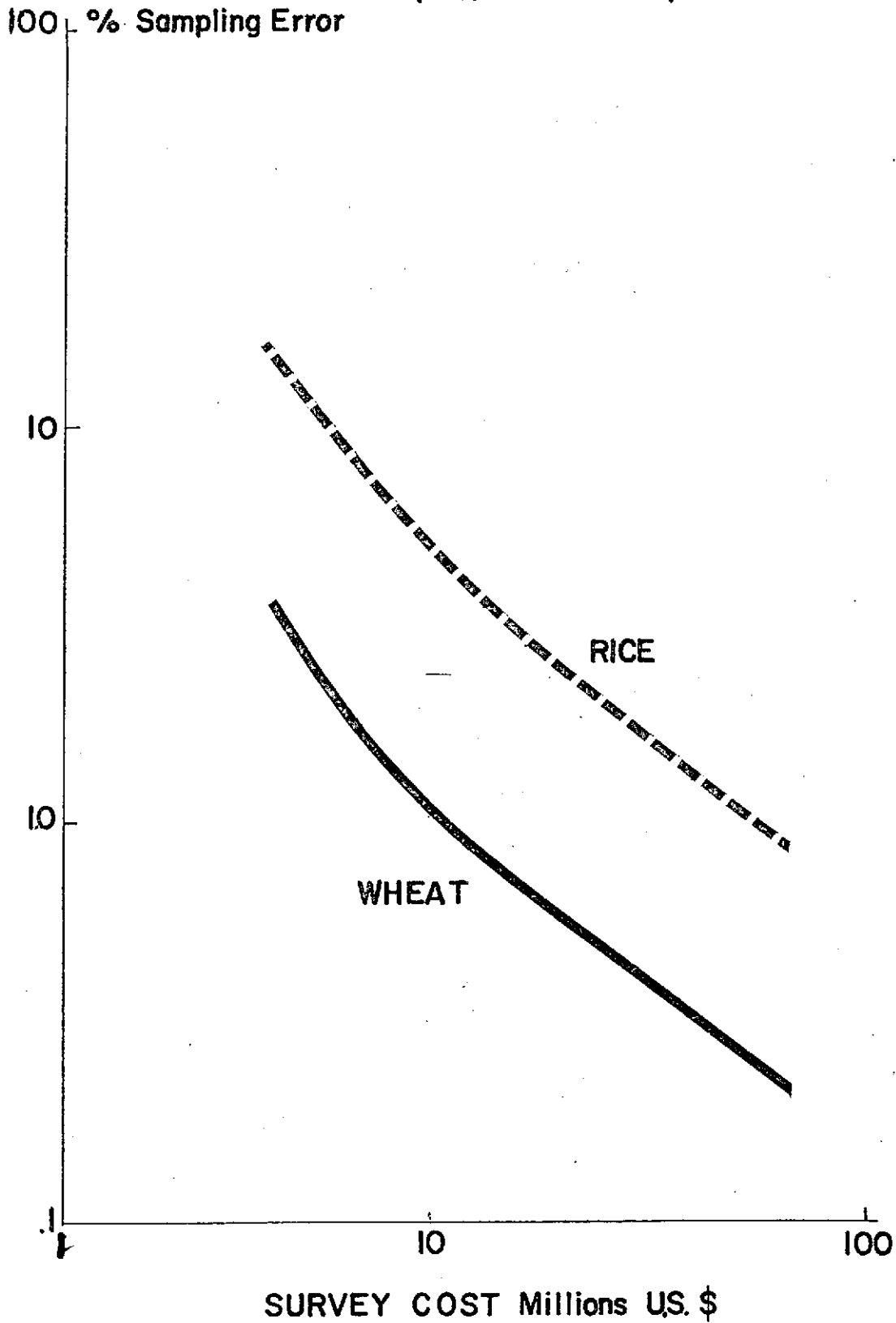
BASIC STRUCTURE OF HAYAMI - PETERSON  
ECONOMIC MODEL

# LOSS DUE TO CROP FORECAST ERROR

(U.S. grain crops after Hayami Peterson)



# COST OF SAMPLE SURVEY FOR VARIOUS SAMPLING ERROR LEVELS (ERS-USDA 1970)



Reports :

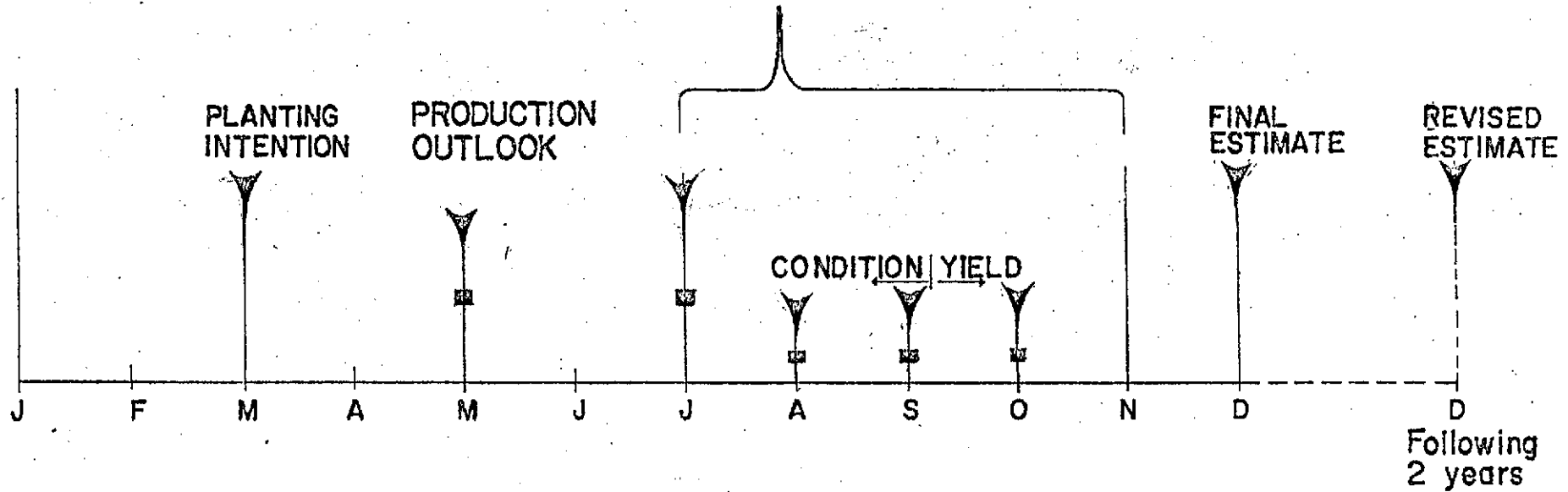
Crop March  
Production PROSPECTIVE  
PLANTINGS

Wheat May  
Situation

HIGHLIGHTS  
OF U.S. CROP  
REPORT AS  
OF AUG

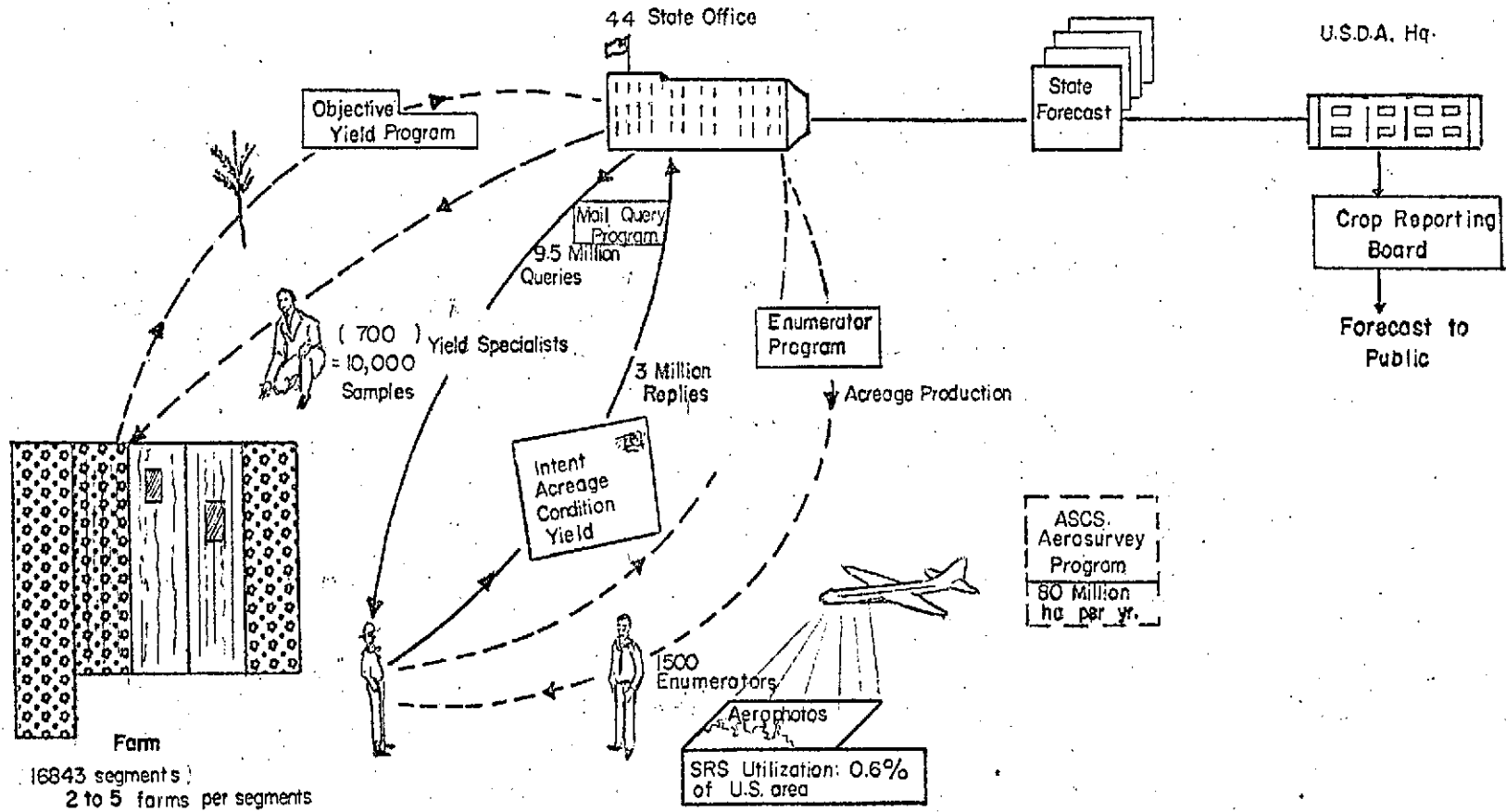
Crop Production  
Annual Summary  
Acreage Yield

Agriculture  
Statistics  
19



### TYPICAL USDA (CORN, WHEAT) FORECAST AND FORECAST RELEASE CYCLE

- ▽ = Reports to Public
- = Forecasts



SIMPLIFIED USDA DATA GATHERING PROCEDURE

JUNE 1974 ACREAGE SURVEY

CROP	ACRES FOR HARVEST	
	THIS YR.	LAST YR.
1. CORN		
2. WHEAT		
3. OATS		
4. BARLEY		
5. RYE		

PLEASE REPORT THE CONDITION AS COMPARED WITH THE NORMAL GROWTH AND VITALITY YOU WOULD EXPECT AT THIS TIME. LET 100 PERCENT REPRESENT A NORMAL CONDITION.

JULY 1	ANSWERS HERE
REPORT FOR YOUR FARM:	↓
ACRES OF CORN HARVESTED LAST YR. _____ ACRES	
ACRES FOR HARVEST THIS YEAR _____ ACRES	
REPORT FOR YOUR LOCALITY:	
ACRES FOR HARVEST THIS YEAR COMPARED WITH ACRES HARVESTED LAST YEAR _____ %	
CONDITION OF CORN _____ %	
PROBABLE YIELD/ACRE _____ BU.	

AMh \_\_\_\_\_

ICD ABOVE (INCLUDE \_\_\_\_\_  
ACRES OF ALL LAND IN THIS FARM  
(INCLUDE LAND RENTED) \_\_\_\_\_

NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_

TYPICAL REPORT FORMATS,  
U.S. FARMERS

PLEASE ANSWER THESE QUESTIONS FOR THE FARM YOU OPERATE	ANSWER HERE
CROP PRODUCTION AND STOCKS	
CORN PRODUCED ON THIS FARM LAST YEAR 70 LB. EAR OR 56 LB. SHELLED BUSHEL	
CORN ON THIS FARM JAN 1, 1974 70 LB. EAR OR 56 LB. SHELLED BUSHEL	
ALL WHEAT PRODUCED ON THIS FARM LAST YEAR - 60 LB. BUSHEL	
ALL WHEAT ON THIS FARM JAN 1, 1974 60 LB. BUSHEL	

USDA FORECAST MODEL, GRAINS

$$P = (A) (AX_1 + BX_2 + CX_3 + DX_4)$$

WHERE:

P = ESTIMATED PRODUCTION (BUSHEL)

A = ESTIMATED ACREAGE

$X_1$  = "CONDITION" AS OF DATE OF SAMPLING, AS REPORTED BY FARMER OR COUNTY AGENT OR STATE

$X_2$  = INCHES OF PRECIPITATION WHICH FELL ON THE AREA IN THE LAST TWO MONTHS PRECEDING DATA OF SAMPLING

$X_3$  = INCHES OF PRECIPITATION ESTIMATED TO OCCUR IN THE NEXT TWO MONTHS FOLLOWING SAMPLING

$X_4$  = CALENDAR TIME, IN WEEKS, ELAPSING FROM MOMENT OF FORECAST

A, B, C, D, = COEFFICIENTS, CALCULATED FROM REGRESSION (LEAST SQUARES) OF THE LAST 15 YEARS EVENTS.



## COUNTRIES INVOLVED IN CROP SURVEY ANALYSIS

SURVEY CLASSIFICATION			
Country	Acreage Forecast	Yield Forecast	Statistical Sampling
<b>EUROPE</b>			
Austria	A	B	--
Belgium	A	B	--
Denmark	A	A	S
Finland	A	A	S
Germany FR.	A	B	S
France	A	D	--
Greece	B	B	--
Ireland	A	A	S
Italy	B	B	S
Luxembourg	A	B	--
Netherlands	A	B	S
Norway	A	B	S
Portugal	C	C	--
Spain	A	B	--
Sweden	A	B	S
Switzerland	A	B	--
United Kingdom	A	C	S
Yugoslavia	B	B	S
<b>NORTH-CENTRAL AMERICA</b>			
Canada	A	A	S
Costa Rica	A	A*	S
Dominican Republic	A	A	--
El Salvador	B	B	--

SURVEY CLASSIFICATION			
Country	Acreage Forecast	Yield Forecast	Statistical Sampling
Guadalupe	B	B	--
Guatemala	A	A*	--
Martinique	B	B	--
Mexico	B	B	--
Panama	A	A*	S
Puerto Rico	A	A*	S
USA	A	A	S
<b>SOUTH AMERICA</b>			
Argentina	A	A	S
Brazil	C	C	S*
Chile	A	D	--
Colombia	A	A*	S*
Ecuador	A	A*	--
Fr. Guiana	--	--	--
Paraguay	A	C	S*
Peru	D	D	--
Surinam	A	A*	--
Uruguay	A	A*	S
Venezuela	B	B	--
<b>ASIA</b>			
Burma	A	A	--
Ceylon	A	B	S
Cyprus	A	A*	--

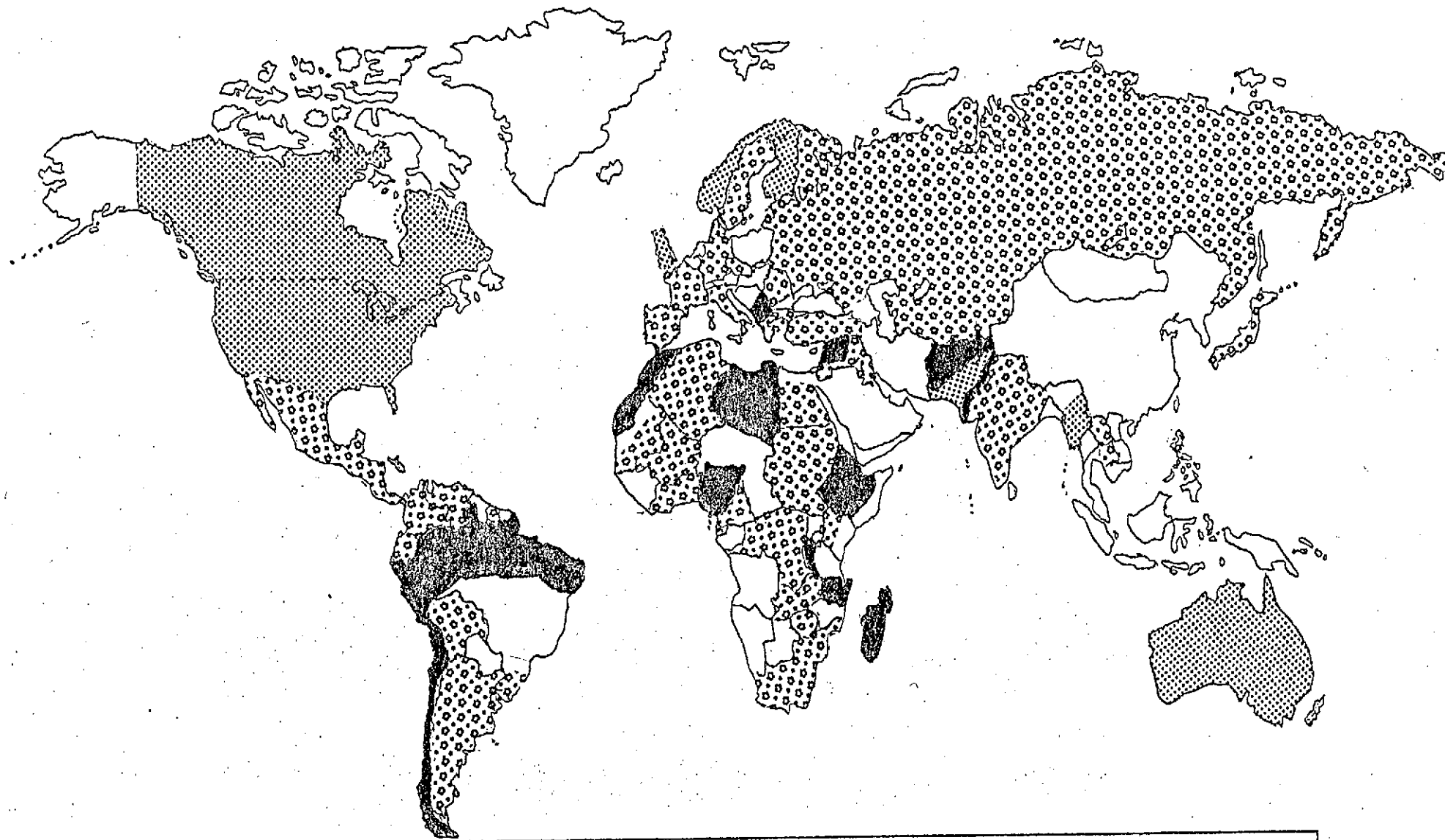
SURVEY CLASSIFICATION			
Country	Acreage Forecast	Yield Forecast	Statistical Sampling
Malaya	A	A*	S
India	A	B	--
Indonesia	B	A	--
Iran	D	D	--
Iraq	C	C	--
Israel	B	B	S*
Japan	A	B	S
Jordan	C	C	--
Lebanon	C	C	--
Pakistan	C	C	--
Phillippines	D	B	--
Syria	C	C	--
Thailand	B	B	--
Turkey	B	B	S
<b>AFRICA</b>			
Algeria	B	B	--
Sudan	B	B	--
Basutoland	D	D	S
Bechuanaland	C	C	--
Belgian Congo	B	B	--
Egypt	A	A*	--
Cameroons, Fr.	A	A*	--
Morocco, Fr.	C	C	--

SURVEY CLASSIFICATION			
Country	Acreage Forecast	Yield Forecast	Statistical Sampling
Somaliland	D	D	--
Togo	A	A*	--
Fr. West Africa	A	A*	--
Gold Coast	A	A*	S*
Kenya	A	A	--
Madagascar	C	C	--
Nigeria	D	D	S*
Rhodesia, Northern	A	A	--
Nyasaland	A	A	--
Rhodesia, So.	A	C	--
Morocco, Sp.	A	A*	--
Swaziland	A	A*	--
Tanzania	D	D	S*
Tunisia	A	A*	--
Union South Africa	A	A	--
Uganda	C	C	S*
<b>OCEANIA</b>			
Australia	A	A	S*
Fiji	A	A	--
Hawaii	A	A	--
New Caledonia	A	A*	--
New Zealand	A	A	S

Explanation of Symbols: **A**. Sampling at farm level    **B**. Sampling at commune level    **C**. Sampling at district level    **D**. Sampling at province level    **S**. Stratified Sampling  
 \* System under development

THE THREE BASIC LEVELS OF CROP FORECASTING SYSTEMS

	<u>Developing</u>	<u>Intermediate</u>	<u>Advanced</u>
	Typical: Dominican Republic	Typical: Italy	Typical: United States of America
Regional Administrative Structure	1599 sections grouped into 69 communes	7851 Communes grouped into 91 Provinces	1700 enumerated areas grouped into 44 States
Crops Surveyed	Maize, rice, beans, potatoes, onions, garlic, peanuts, coconuts, oranges, bananas, cocoa, sugar cane, plantains, pineapple, coffee (in pod), avocado, pears, cotton, tobacco	Wheat, rye, barley, oats, maize, rice, sugar beets, potatoes, peas, beans, vineyards, fruits, olives, linseed rapeseed, vegetables, tobacco, fibers	Grains, fodder crops, tuber and root crops, sugar crops, pulses, oilseeds, hay and grass seeds, vegetable seeds, fruits, nuts, vegetables, tobacco, fibers
Methods of Data Gathering	<ul style="list-style-type: none"> <li>• Interview of producers by enumerators</li> </ul>	<ul style="list-style-type: none"> <li>• Crop area from personal judgement, supplemented by cadastral survey</li> <li>• Crop yields from local inquiry</li> </ul>	<ul style="list-style-type: none"> <li>• Direct inquiry to farmer respondents</li> <li>• Enumerators with aerial photos</li> <li>• Objective yield measurement by specialists</li> </ul>
Sampling Structure	None	Simple sampling procedure	Multi-frame stratified sampling procedures
Organization	Municipal Statistical Board in each commune	<ul style="list-style-type: none"> <li>• Data from commune collected by local correspondent assisted by provincial agricultural inspector</li> <li>• Central Institute of Statistics issues technical directives and publishes results</li> </ul>	<ul style="list-style-type: none"> <li>• SRS HQ staff supported by 44 State offices comprising 9 crop regions.</li> <li>• Refer to Figure 9</li> </ul>
Frequency of Crop Reporting	Every 3 months	Two crop reports per year. First estimate at planting time; second estimate at harvest	Multiple crop reports per year. Intentions to plant-yearly per crop. Acreage, crop condition, production forecast - monthly for 3-6 months. Final production and yield-yearly.



**Agricultural Data Gathering System**



**Sophisticated**



**Medium Complexity**



**Simple**



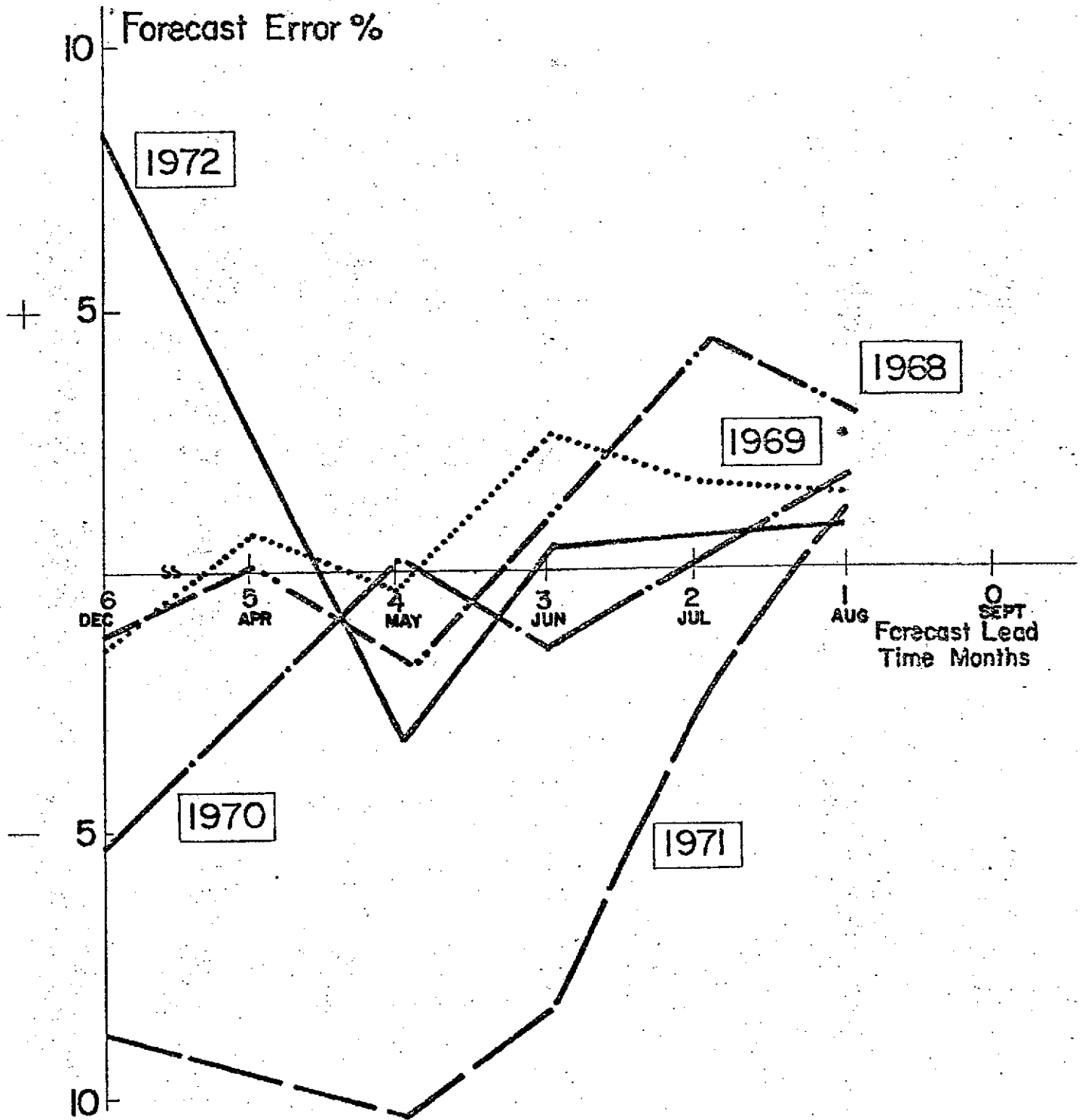
**No data**

**Distribution of Crop Forecasting Activities**

YEARLY COST OF WORLDWIDE CROP SURVEY/FORECAST

Region	Per Capita GNP Ratio	Weighted Survey Factor	Survey/ Forecast Cost Million U.S. \$
North America U.S. Canada	1 0.084	1 0.7	42.4 40 2.4
Western Europe	1.72	0.7	48.2
Eastern Europe	0.89	0.25	8.9
Latin America	0.11	0.15	0.7
Africa/Mid-East	0.15	0.07	0.4
Asia	0.53	0.10	2.1
Oceania	0.05	0.7	1.5
<u>WORLD</u>			<u>104.2</u>

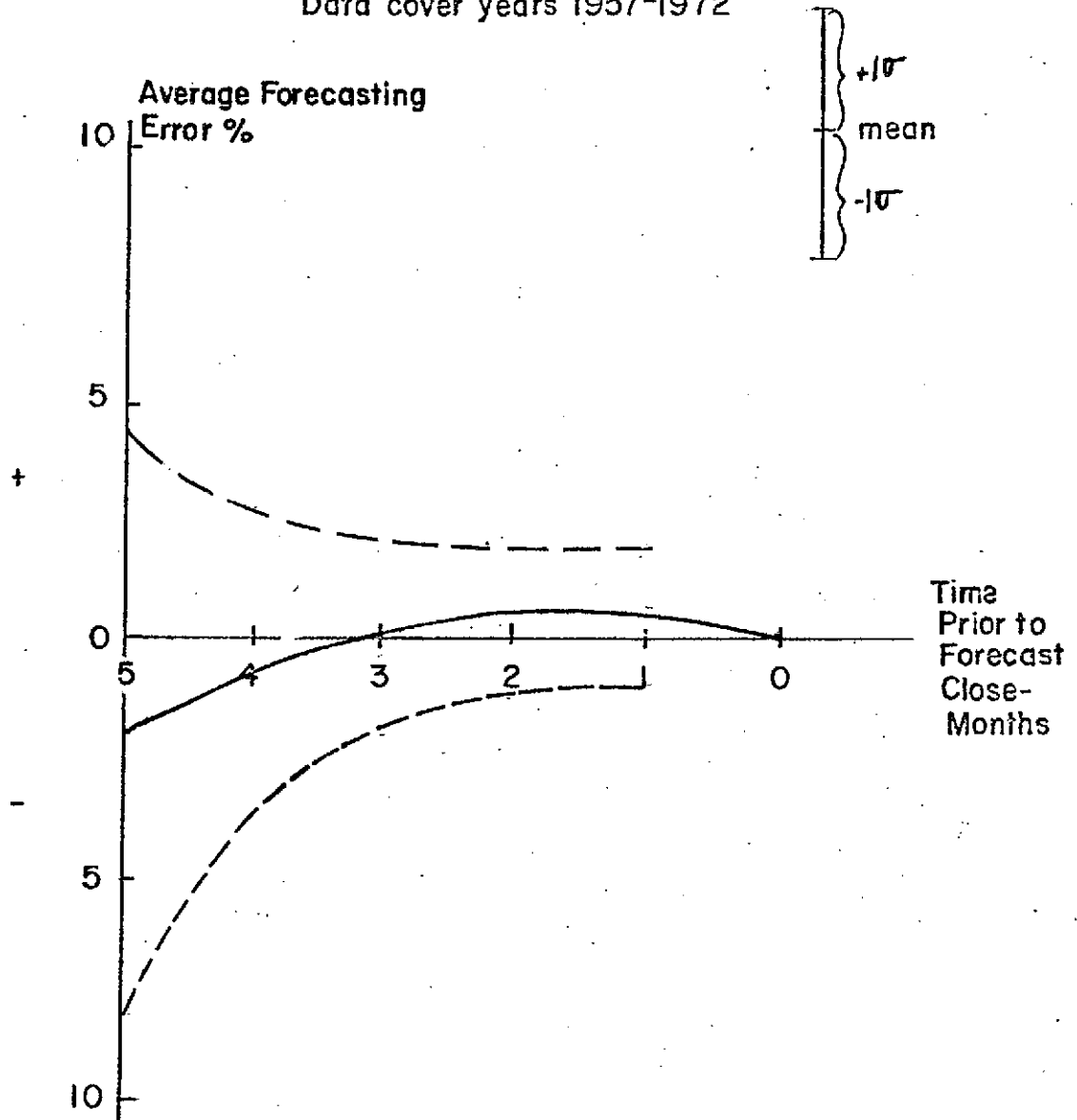
# PUBLISHED USDA-SRS FORECAST ACCURACY WINTER WHEAT - TOTAL U.S. CROP



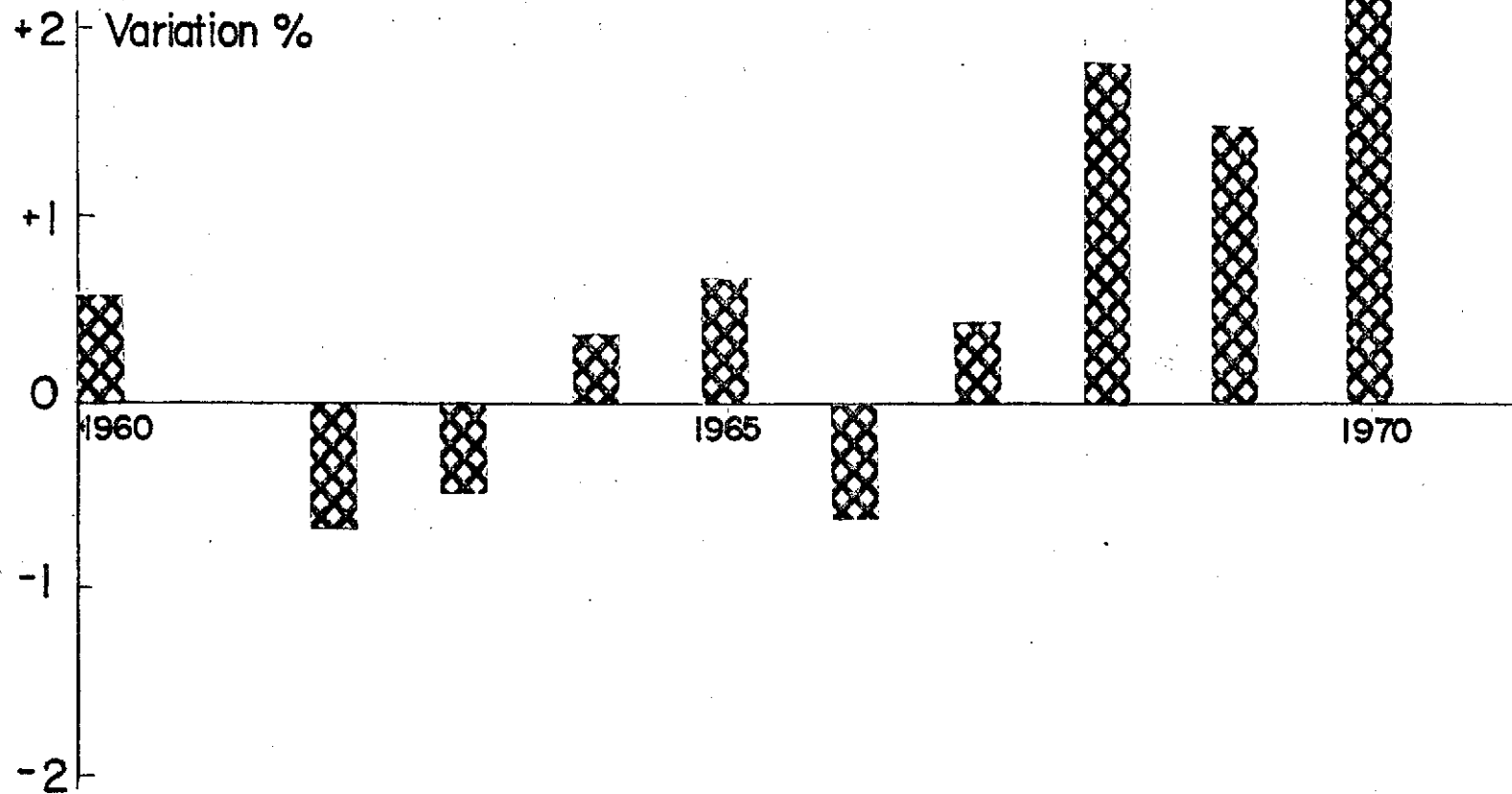
# USDA-SRS Average Crop Forecasting Error Versus Time Prior to Crop Year Close

(All Wheat)

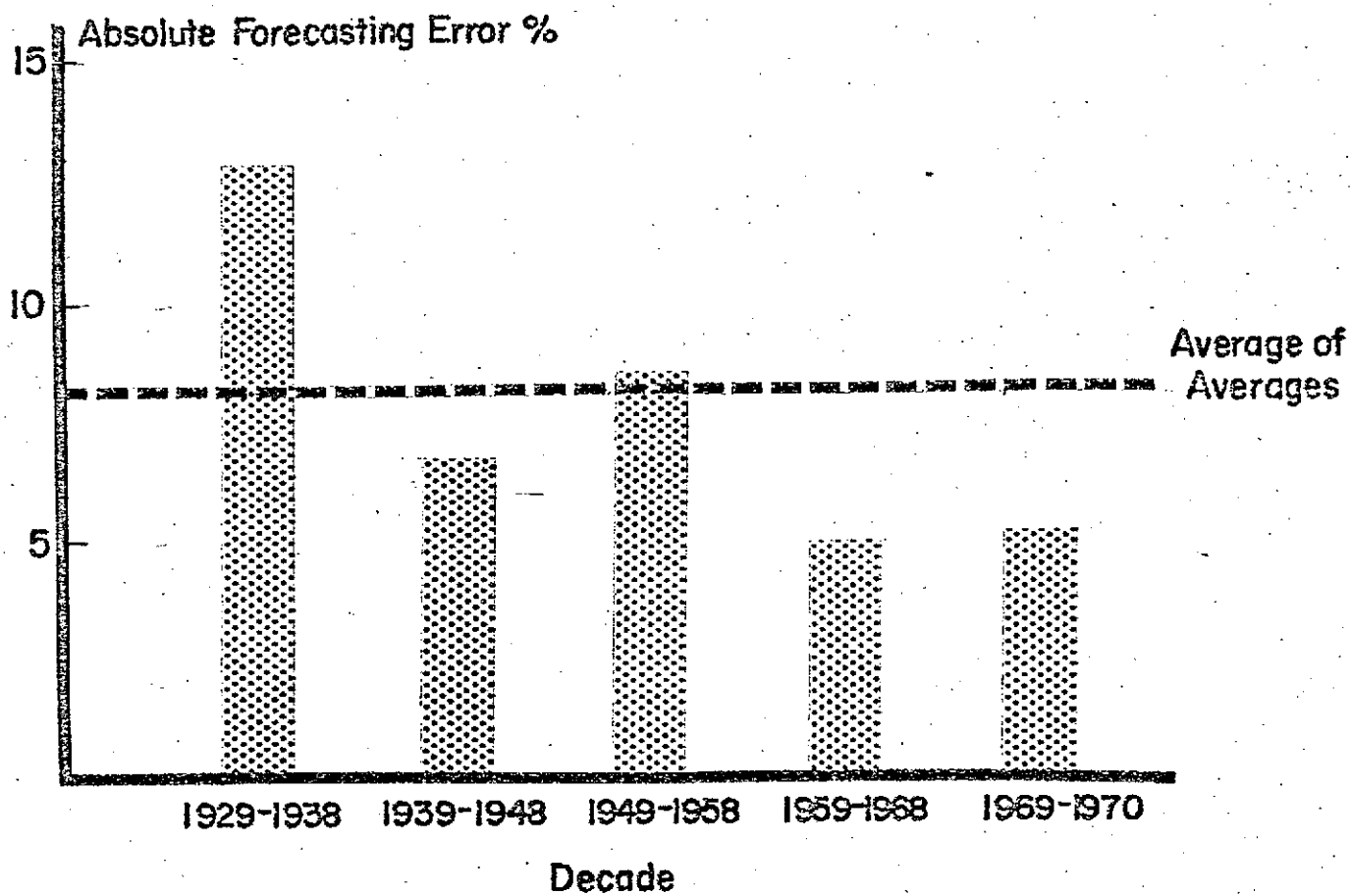
Data cover years 1957-1972



# VARIATION BETWEEN PRELIMINARY AND FINAL WINTER WHEAT ESTIMATE

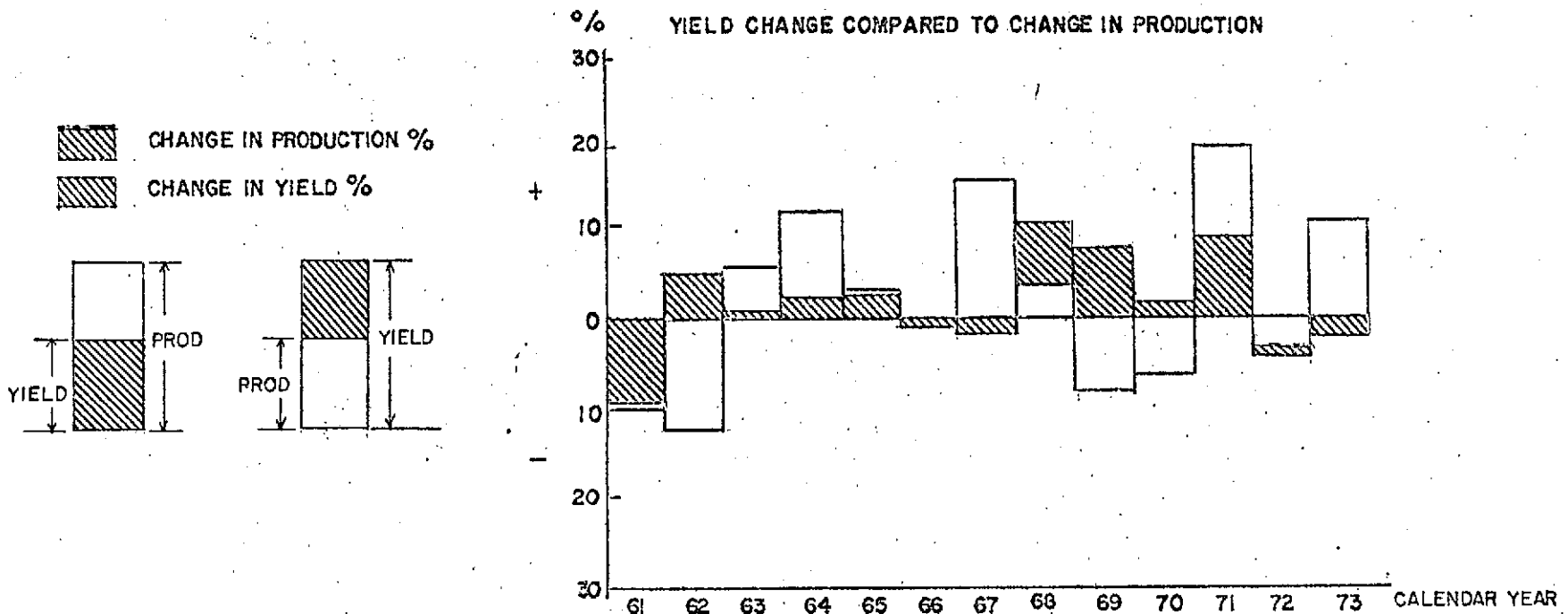
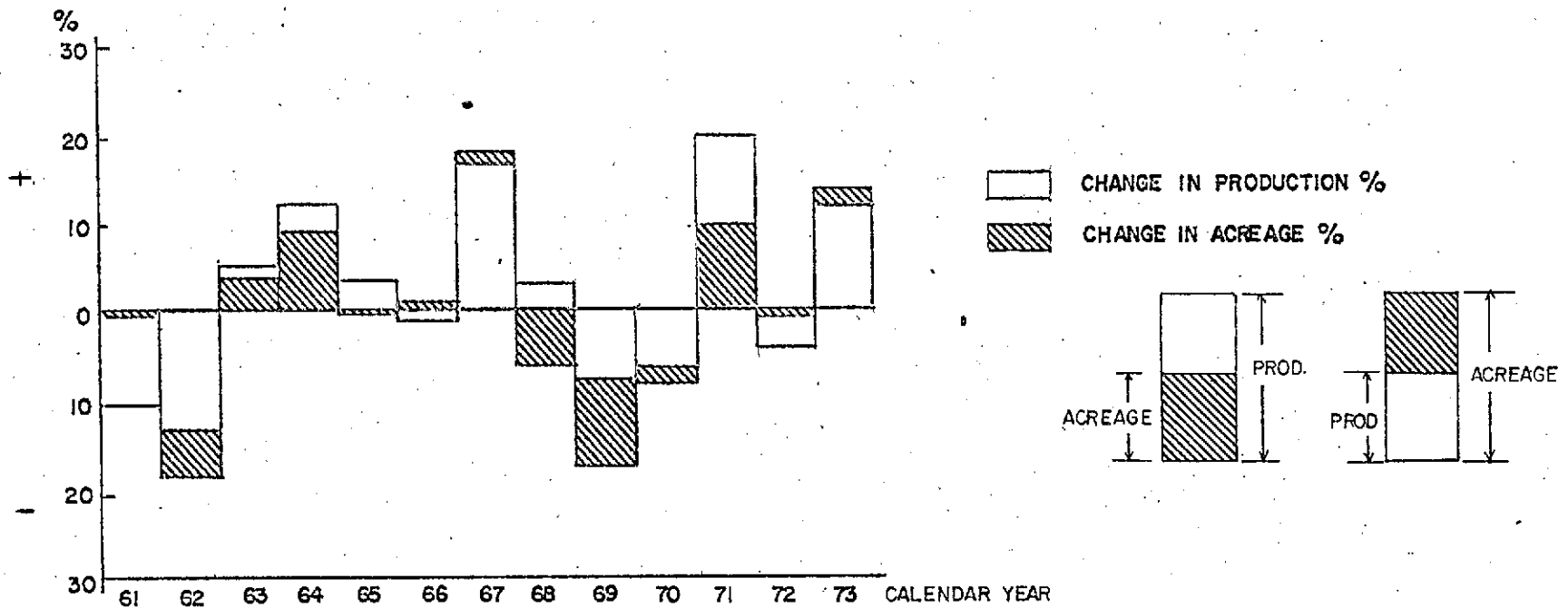


# TREND OF AVERAGE USDA FORECASTING ERRORS (major commodities)

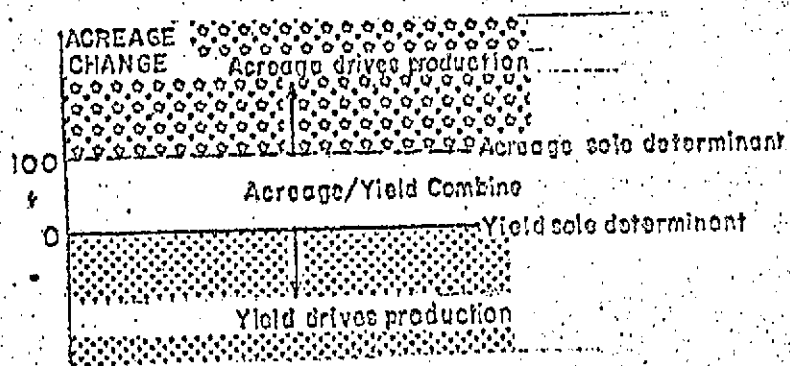
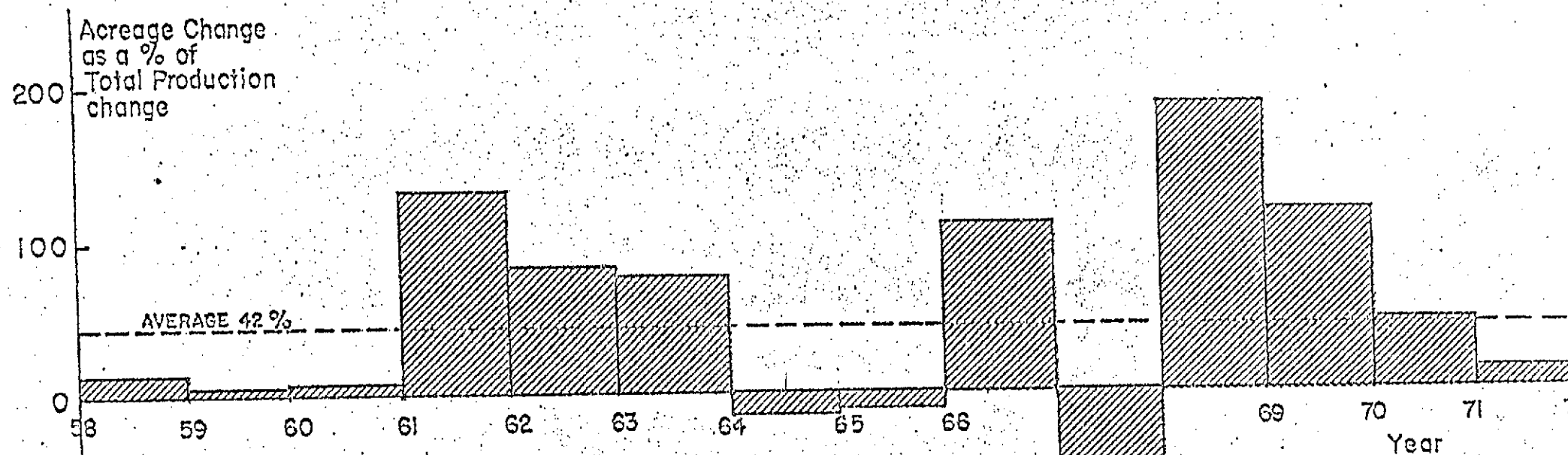




THE EFFECT OF CHANGES IN ACREAGE YIELD  
ON TOTAL PRODUCTION OF WHEAT





# CONTRIBUTION OF ACREAGE HARVESTED TO TOTAL WHEAT PRODUCTION

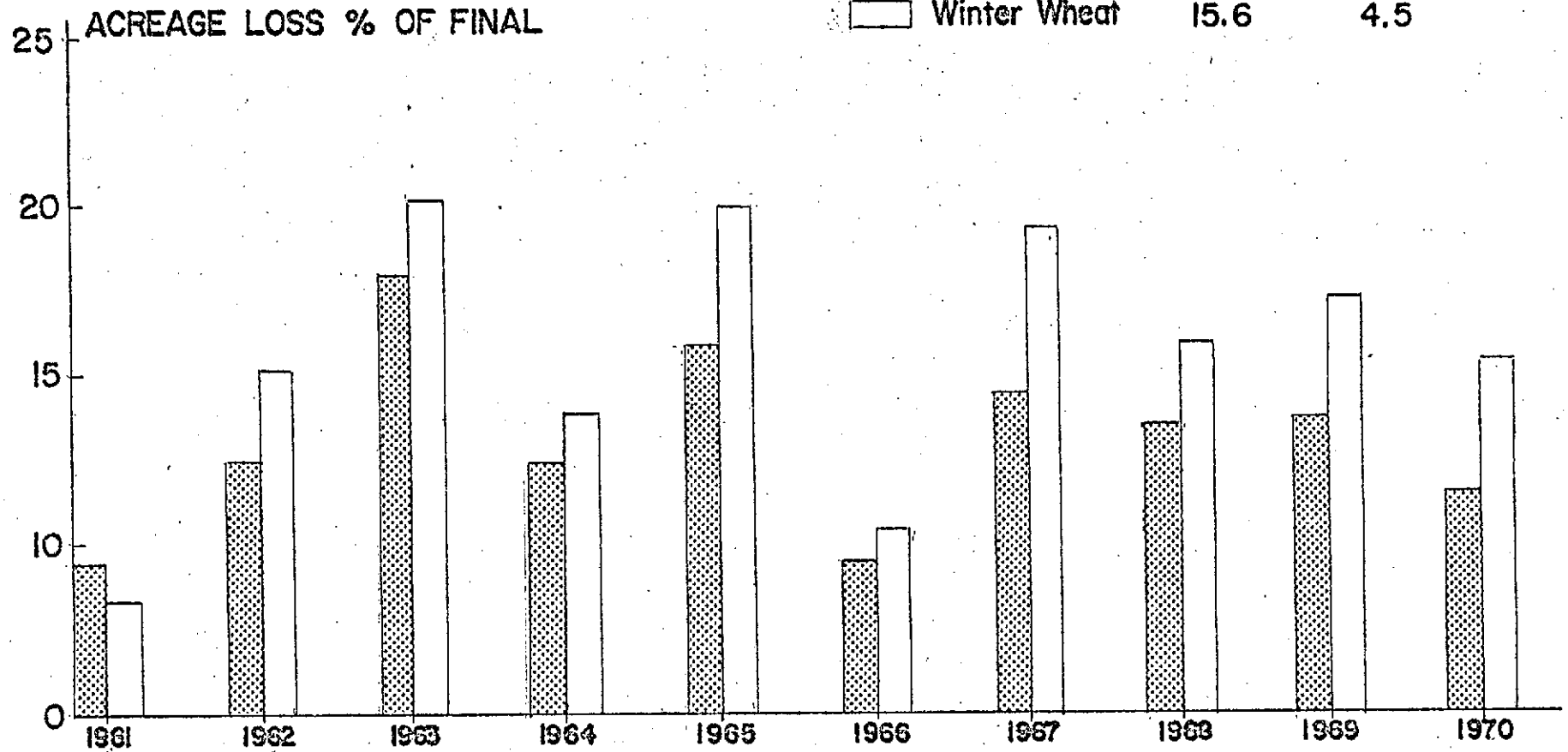


KEY: +100% MEANS ACREAGE CHANGE WAS FULLY RESPONSIBLE FOR PRODUCTION CHANGE  
 >+100% " " " WAS GREATER THAN PRODUCTION CHANGE (YIELD DIMINISHED)  
 0% " " " DID NOT INFLUENCE PRODUCTION CHANGE  
 -VALUES " " " VARIED OPPOSITELY TO PRODUCTION CHANGE

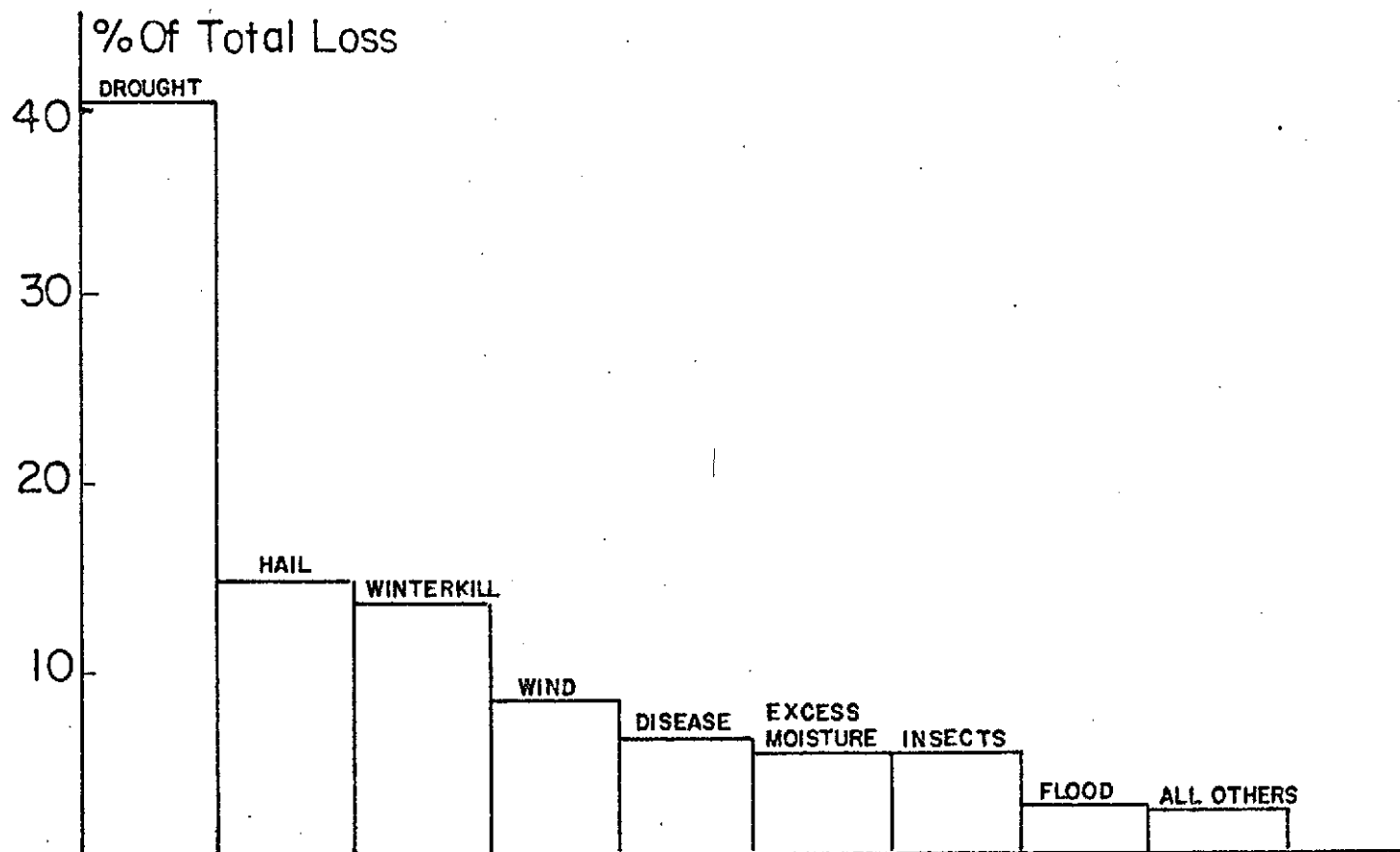
# ACREAGE LOST IN U.S. DURING GROWING SEASON

% OF TOTAL	
AVERAGE	1 $\sigma$ VARIANCE

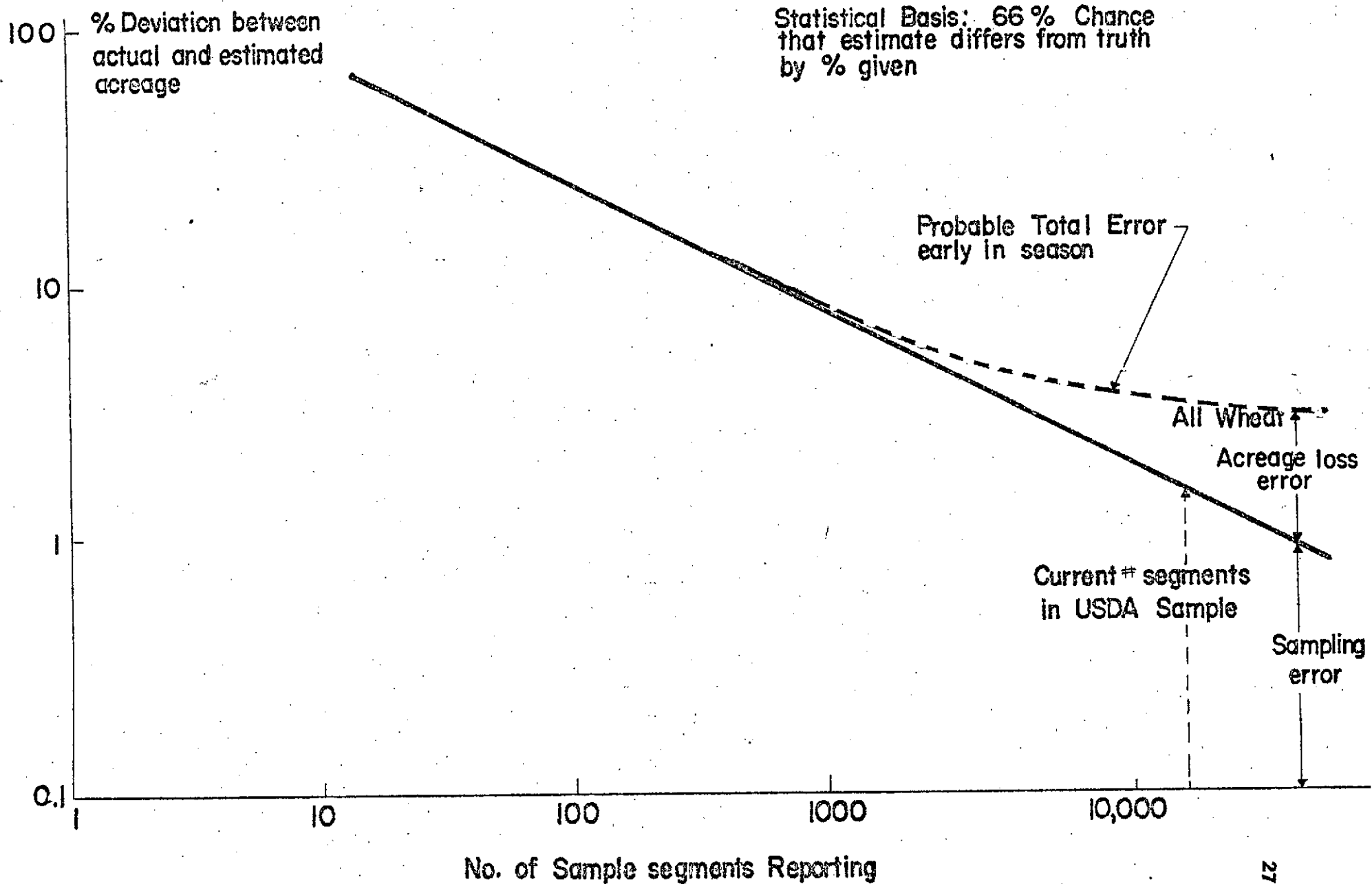
 All Wheat	13.1	3.0
 Winter Wheat	15.6	4.5



# CROP LOSS CAUSES : WHEAT (1939-69)



# ACREAGE MEASUREMENT ACCURACY BY USDA SAMPLING PROCEDURE

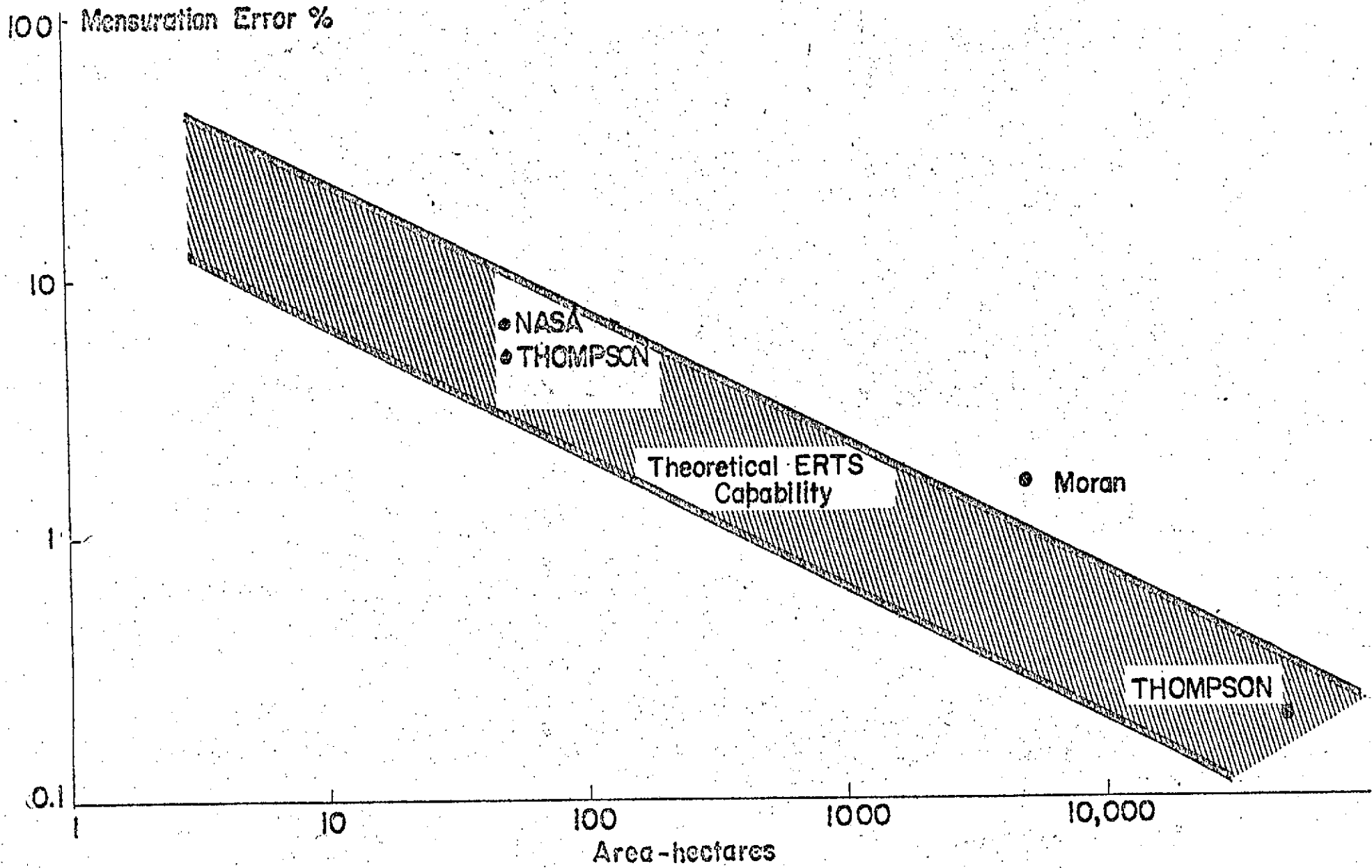


ACCURACY OF REMOTELY SENSED CROP DISCRIMINATION

CROP	%Correct Identification	
	AIRCRAFT (Scale 1:4000)	SATELLITE (ERTS)
Small grains	100	---
Row crops	96	96
Pasture	96	84
Trees	100	86
Wheat	95	93
Oats	95	85
Water	100	100

--- = not available

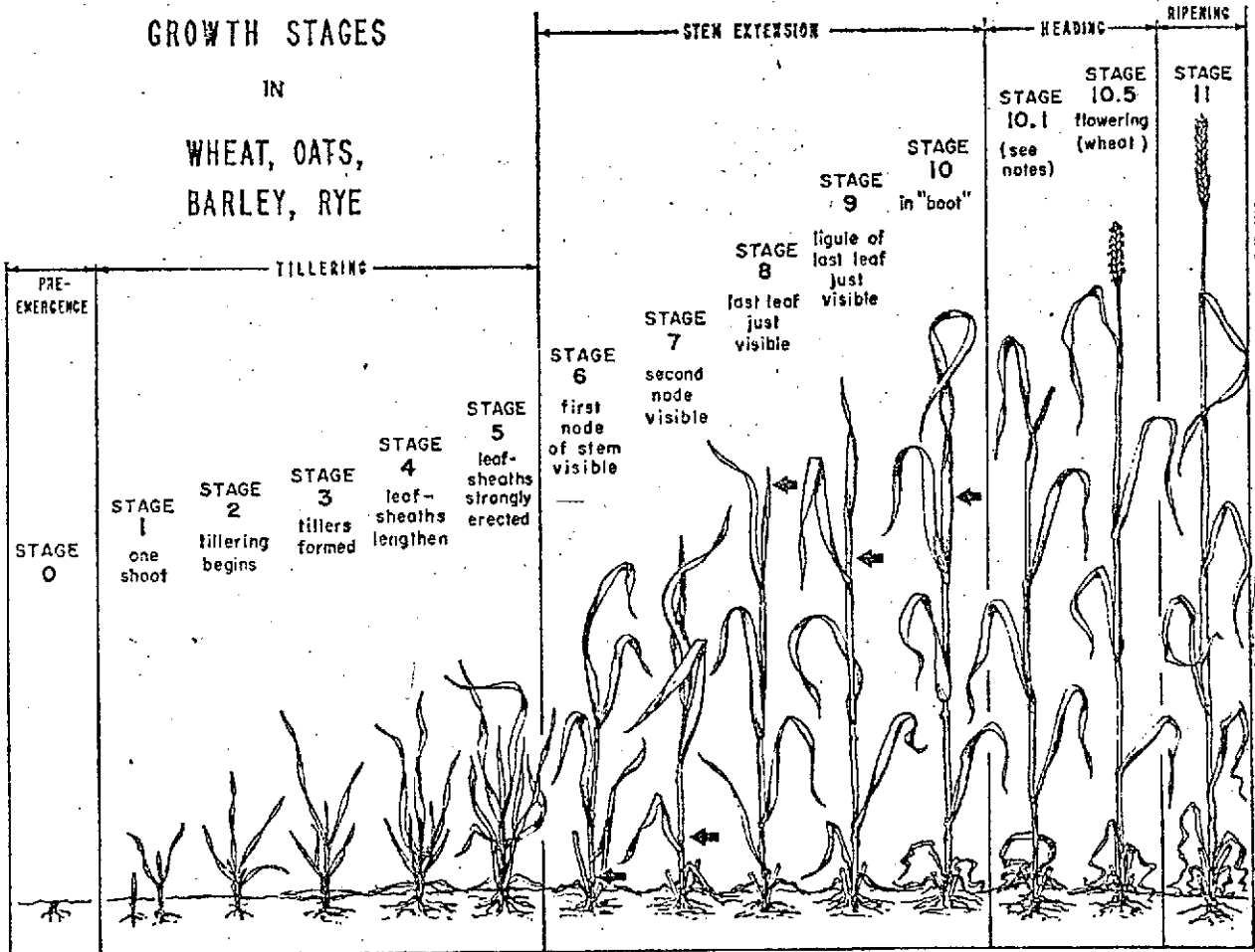
# COMPARISON OF ERTS RESULTS TO THEORETICAL MENSURATION ERROR



GROWTH STAGES

IN

WHEAT, OATS,  
BARLEY, RYE



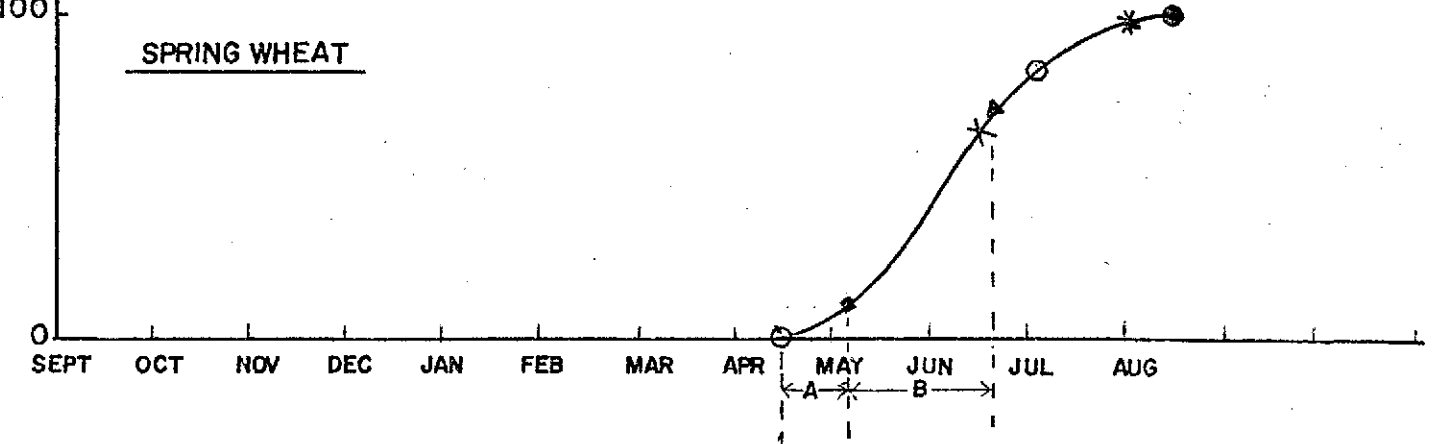
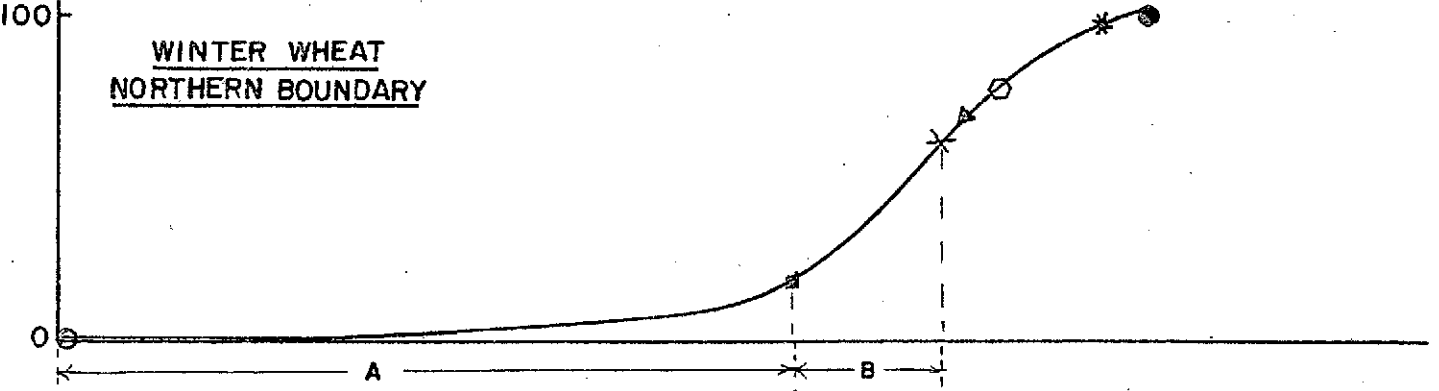
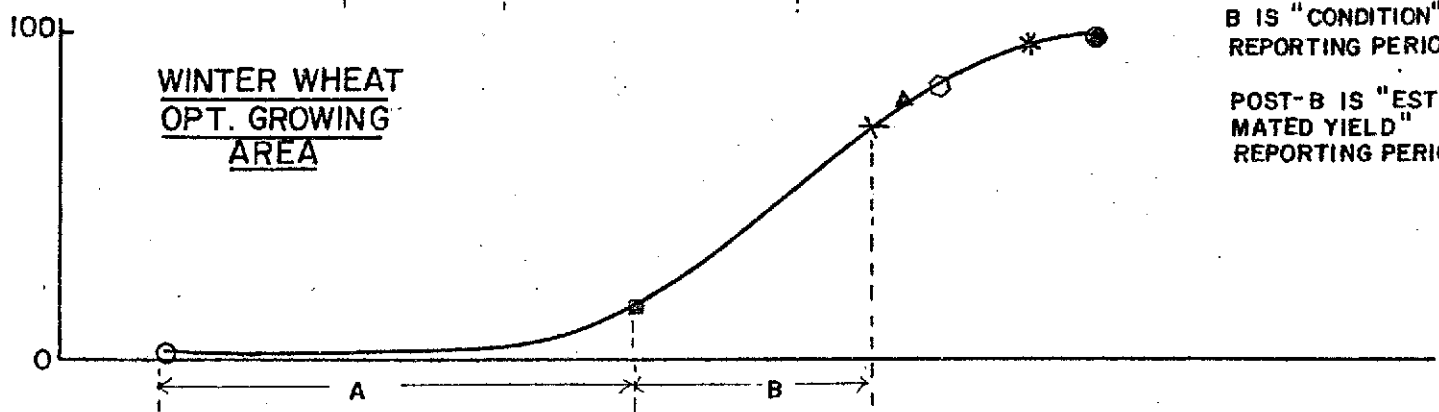
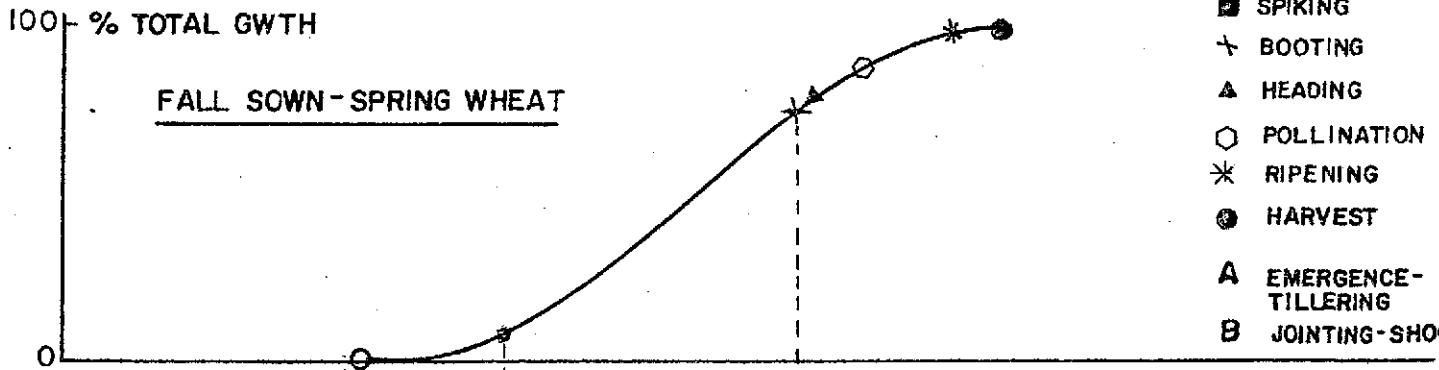


# TYPICAL GROWTH PATTERN OF MAJOR WHEAT TYPES

KEY

31

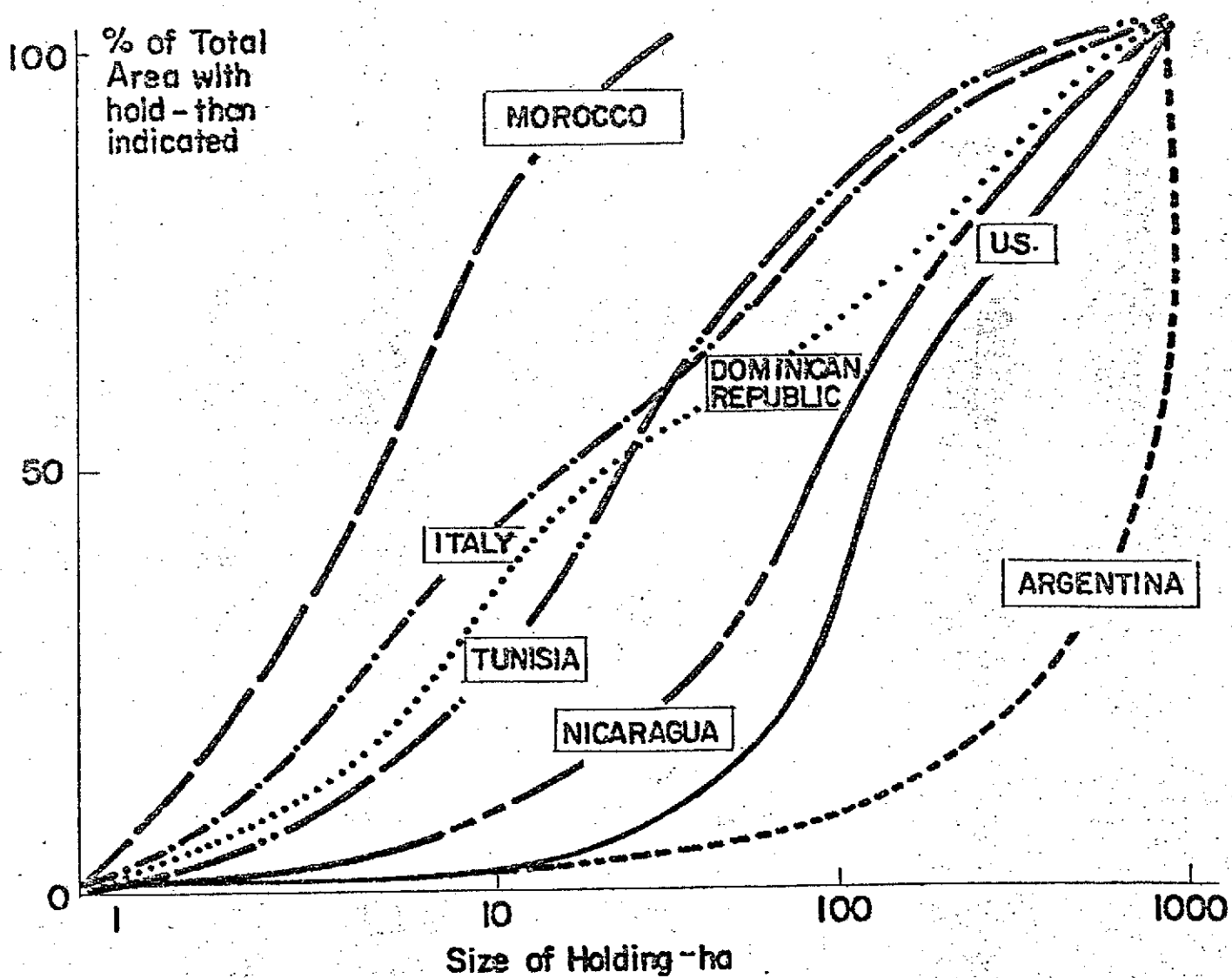
- SEEDING
- SPIKING
- + BOOTING
- ▲ HEADING
- ◇ POLLINATION
- \* RIPENING
- HARVEST
- A EMERGENCE-TILLERING
- B JOINTING-SHOOTING



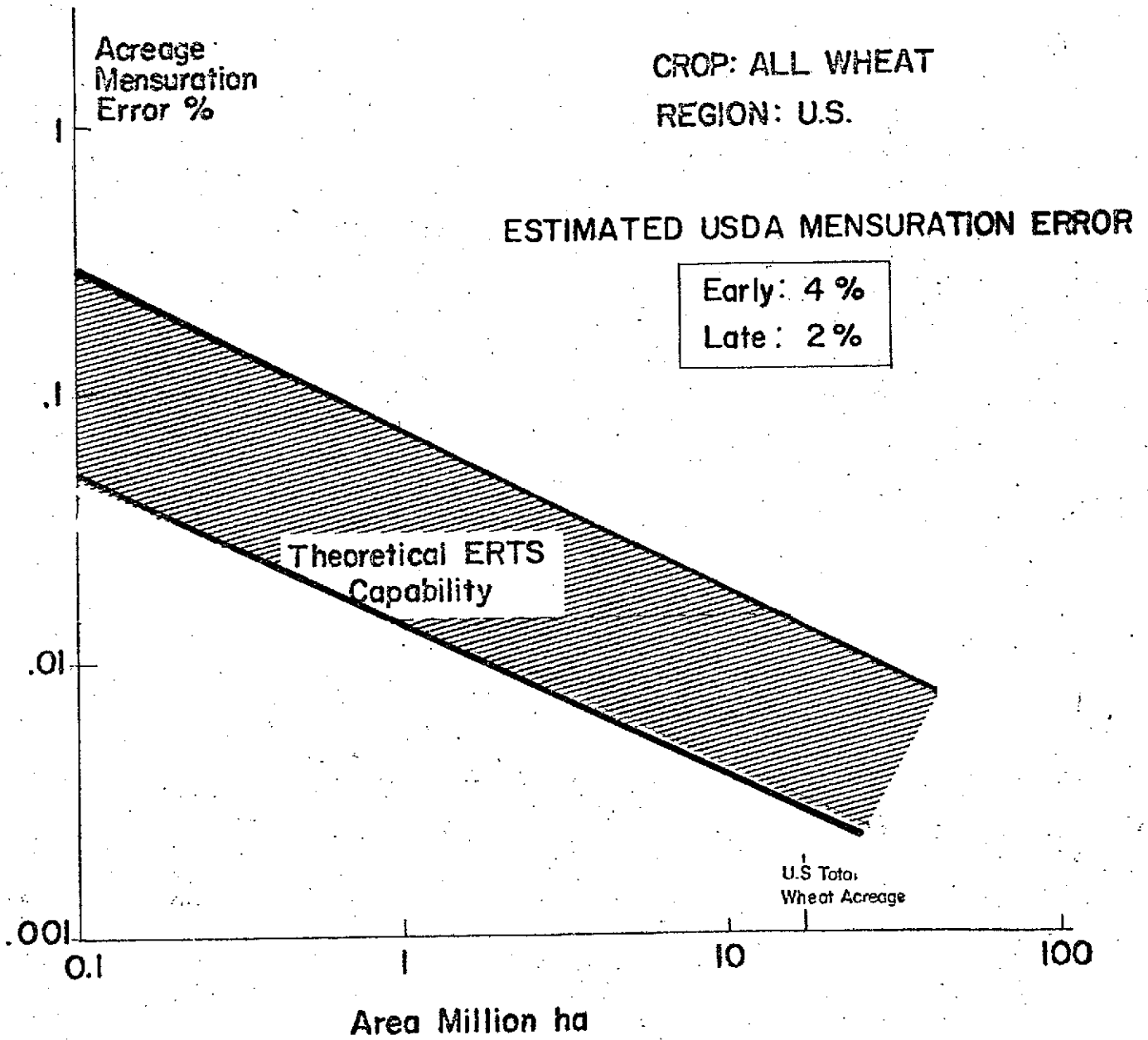
B IS "CONDITION" REPORTING PERIOD  
POST-B IS "ESTIMATED YIELD" REPORTING PERIOD

SEPT OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG

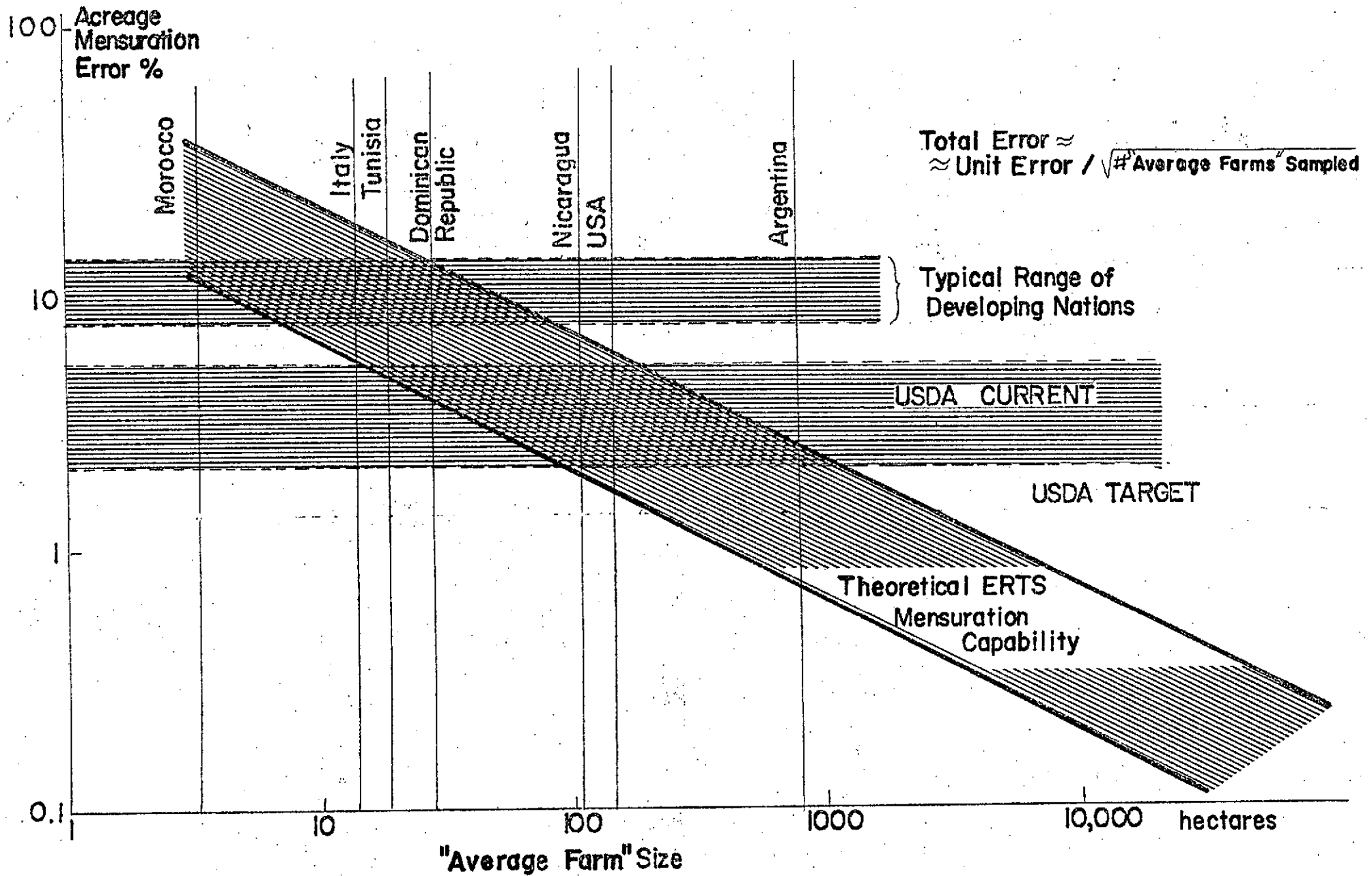
# CROP AREA DISTRIBUTION



# THEORETICAL ACCURACY OF CROP ACREAGE MEASUREMENT BY ERTS



# THEORETICAL UNIT MENSURATION ERROR (ERROR ON THE "AVERAGE FARM")



**THEORETICAL "BEST" MENSURATION ERROR FOR  
SELECTED COUNTRIES - WHEAT ACREAGE**

