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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 G3/13

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PREPARED BY

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

April 5, 1974

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VALUE OF REMOTE SENSING AGRICULTURAL CROP FORECASTING

PRESENTATION TO

BENEFIT/COST TASK FORCE

22 MARCH 1974

ECOSYSTEMS INTERNATIONAL, INC.

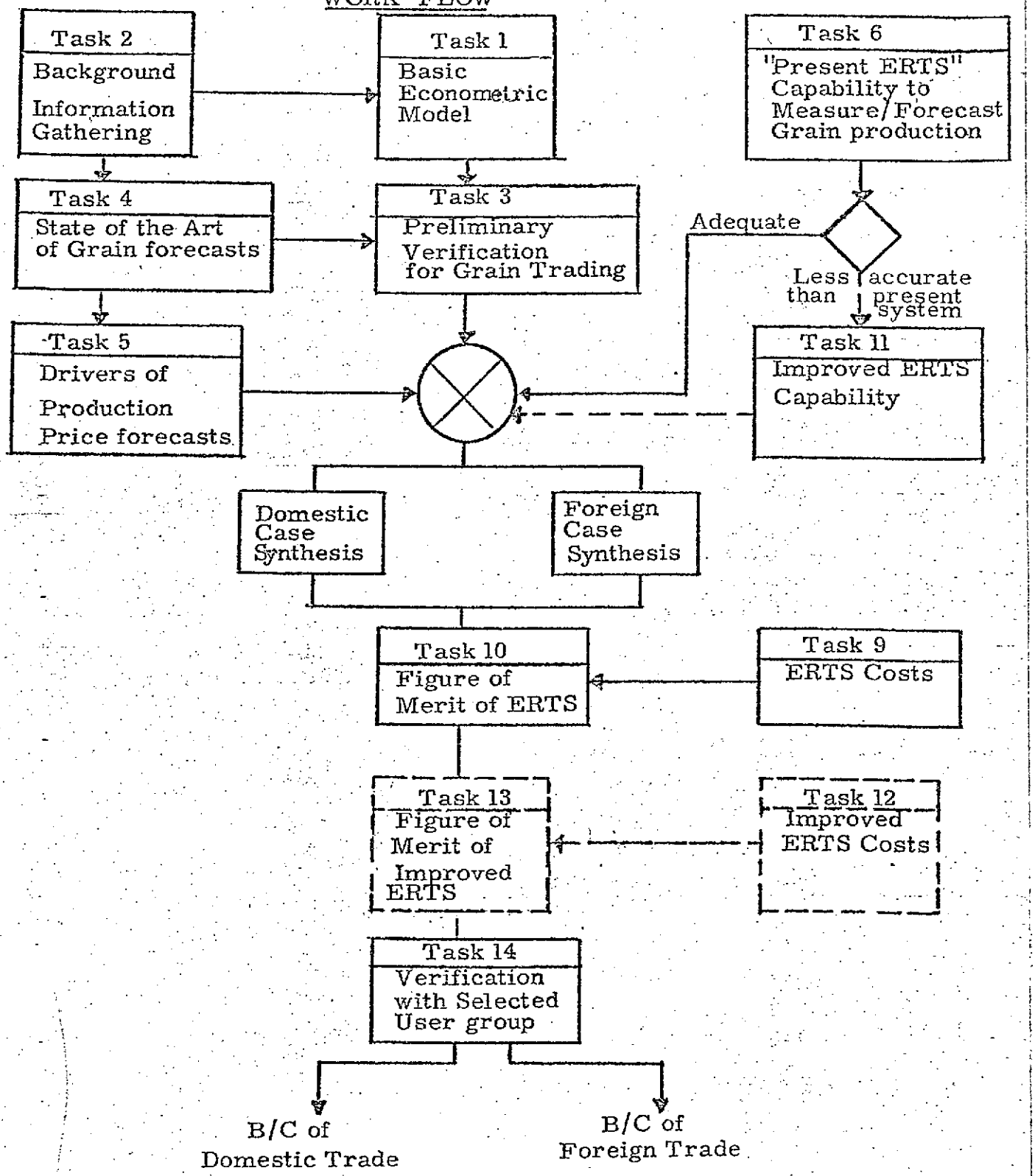
Post Office Box 225

Gambrills, Maryland 21054

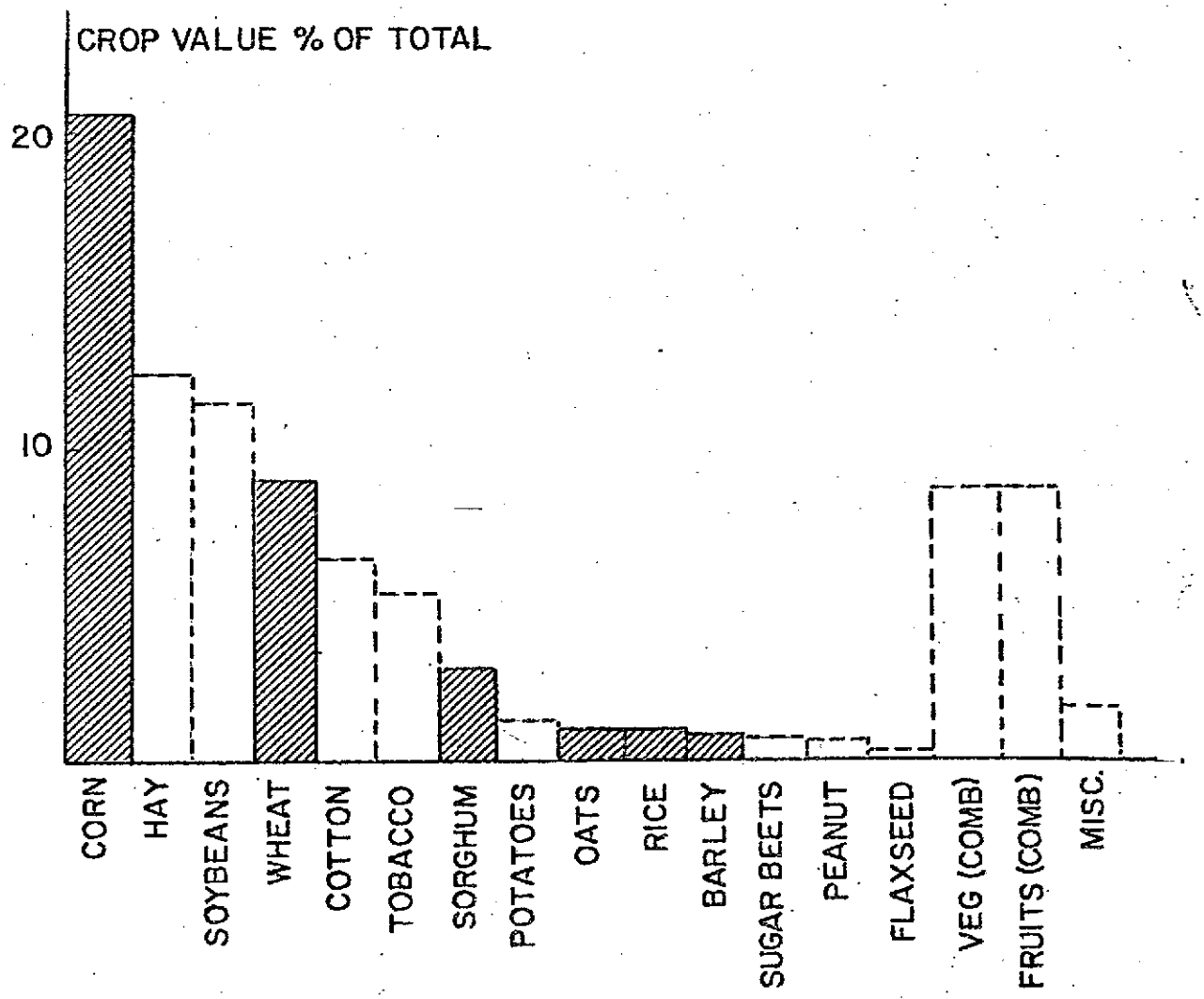
(301) 987-4976

AGRICULTURAL COMMODITY FORECASTING

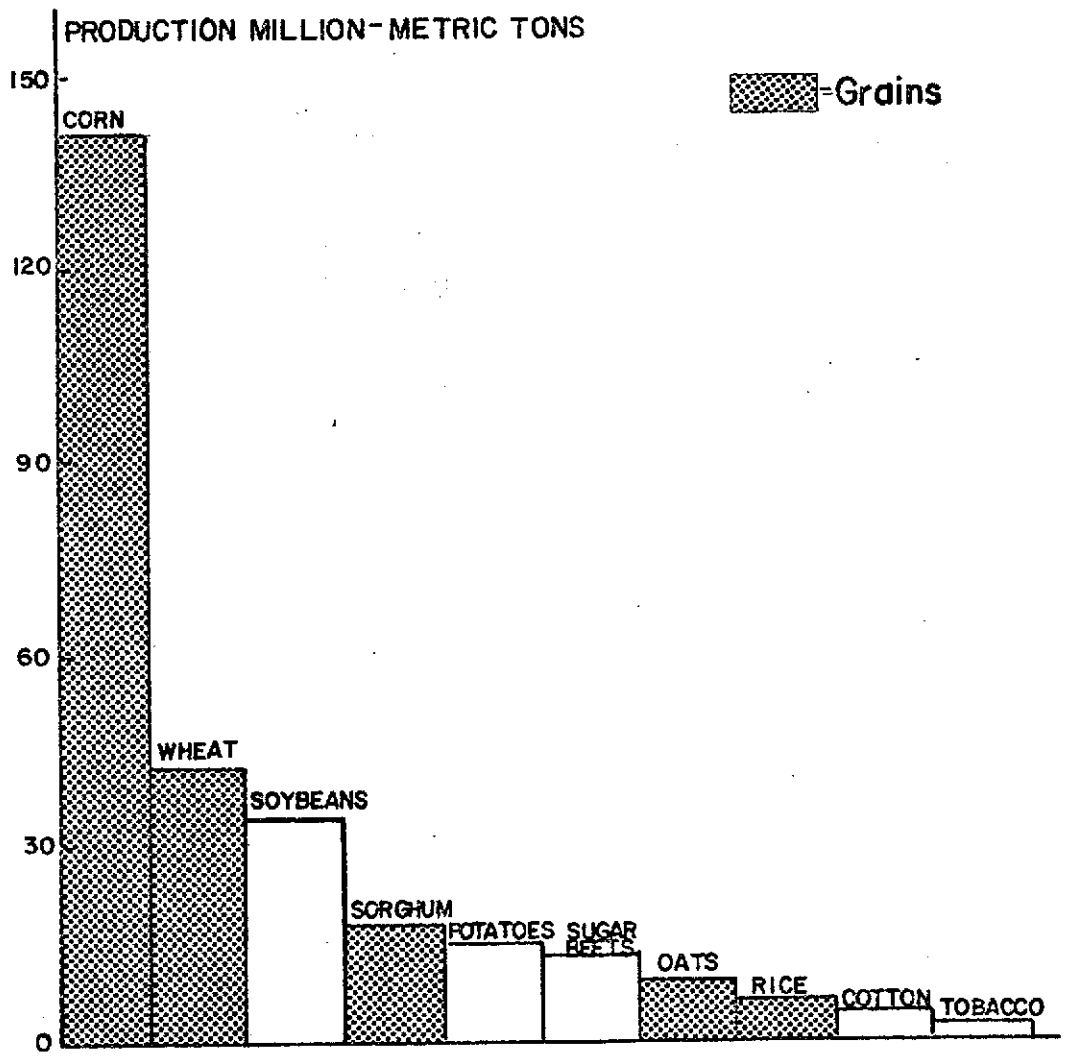
WORK FLOW



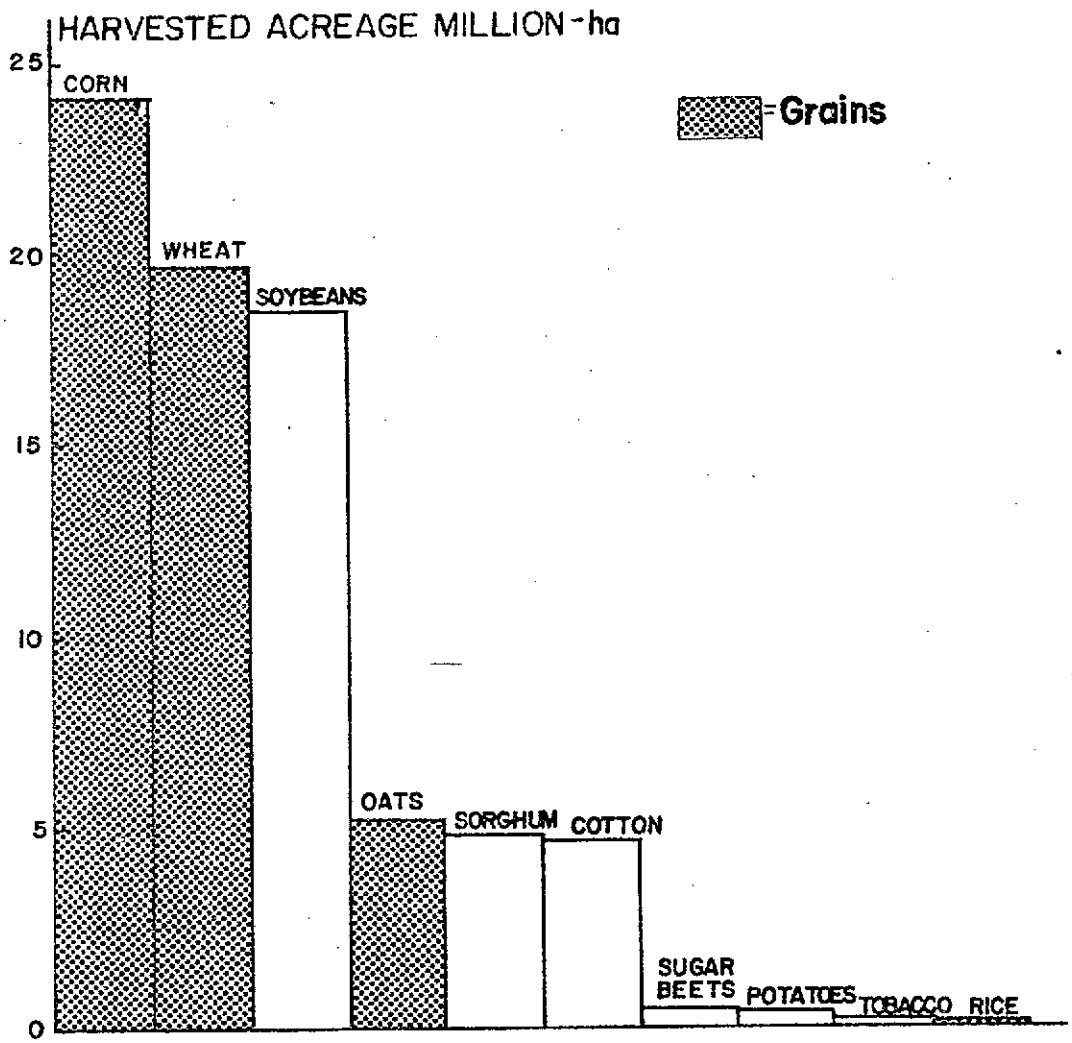
RELATIVE VALUE OF U.S. CROPS



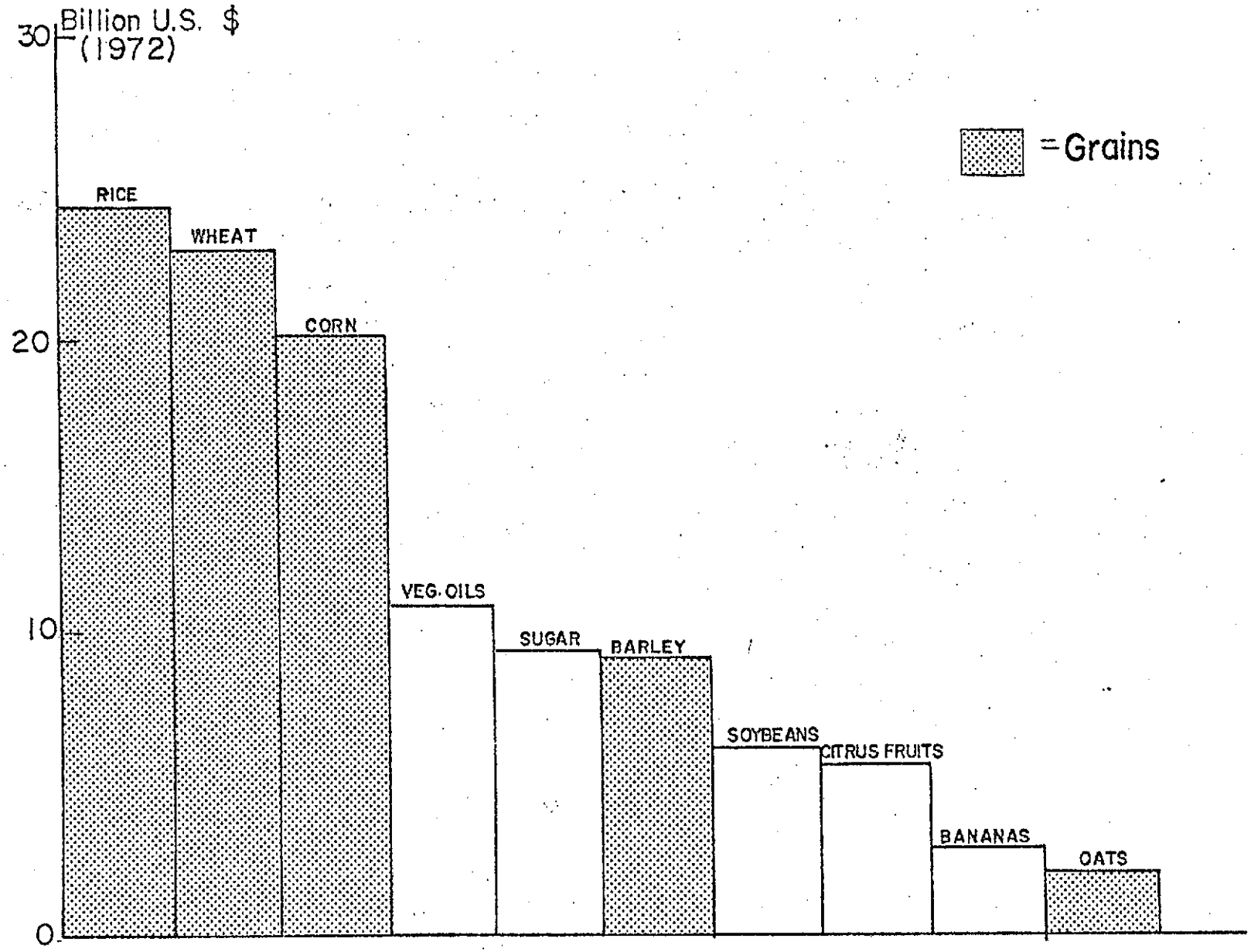
UNITED STATES PRINCIPAL CROPS-1972



UNITED STATES PRINCIPAL CROPS 1972

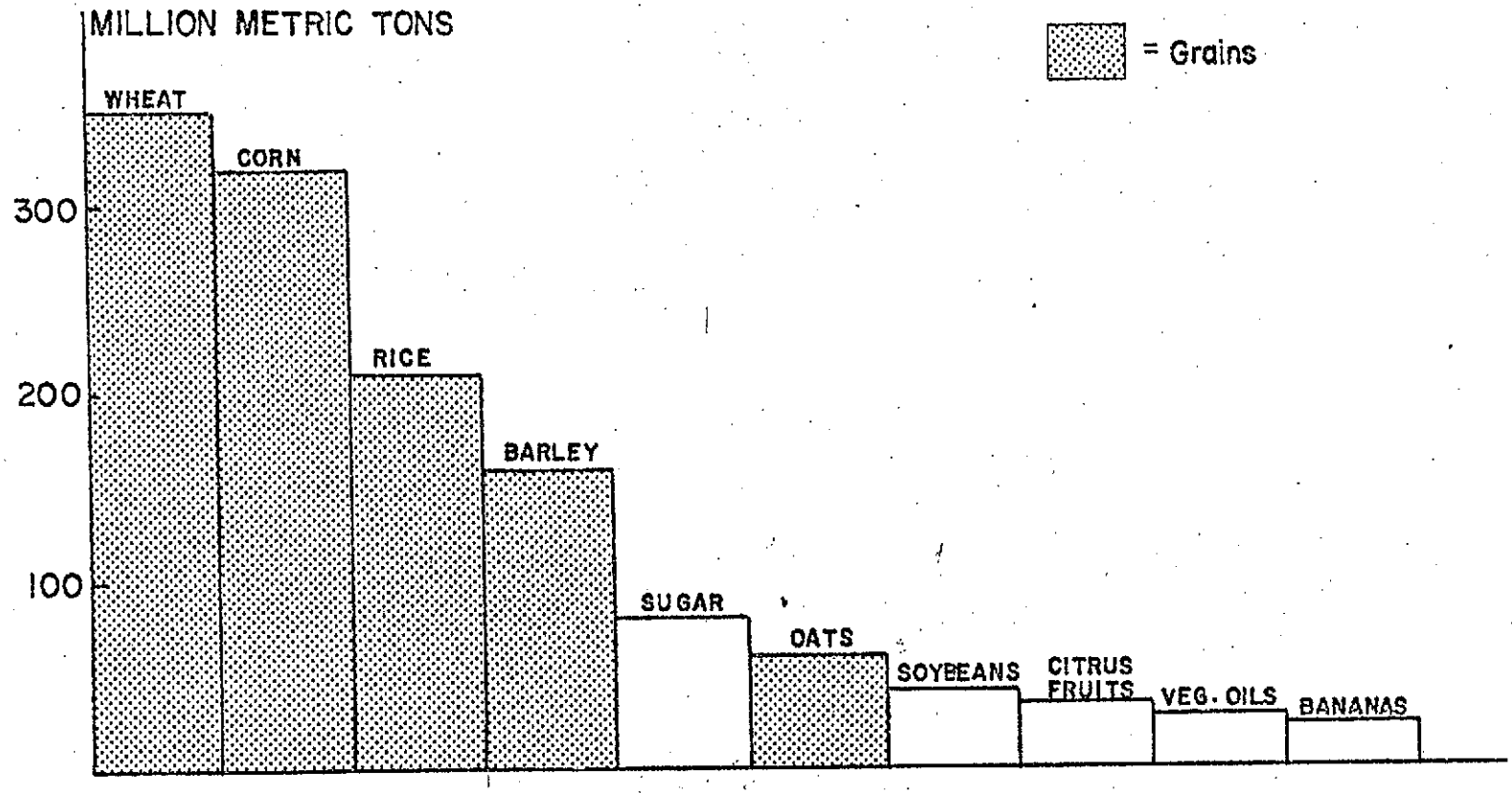


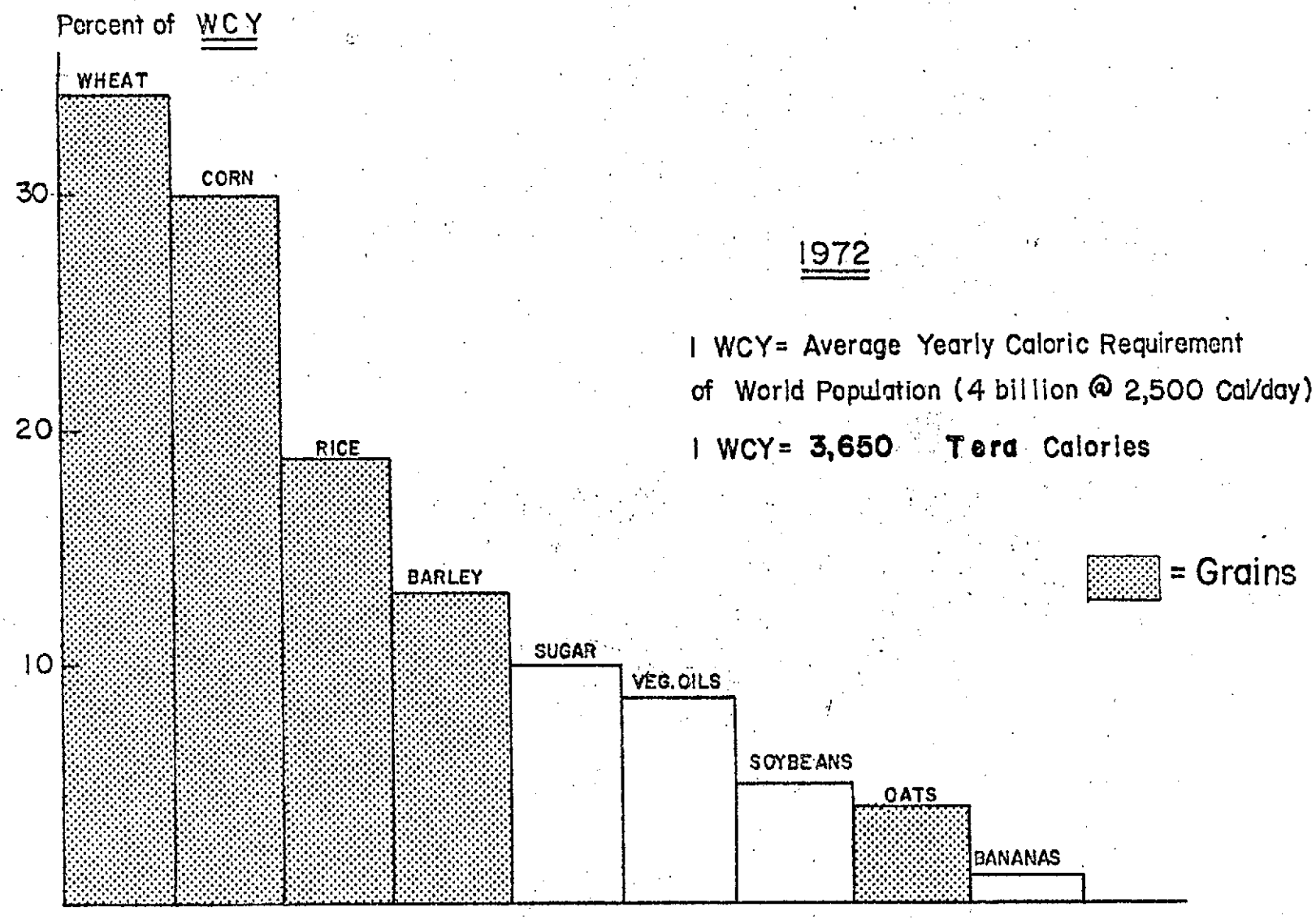
TOTAL WORLD STAPLE CROP VALUE (1972) AT EXPORT PRICES



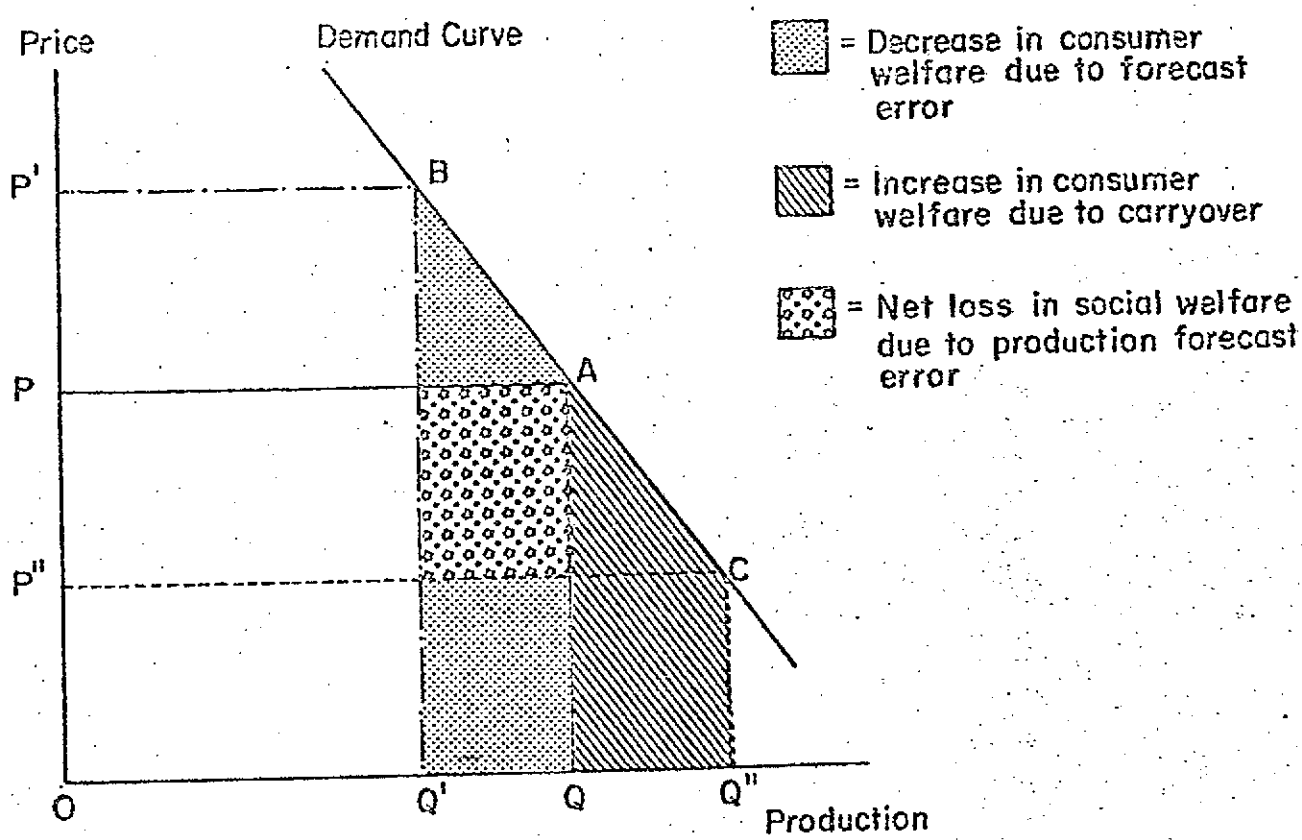
WORLD STAPLE CROP PRODUCTION

(1972)





CALORIC CONTENT OF WORLD STAPLE CROPS



OQ = True Production

OP = Price which would correspond to OQ

OQ' = Forecasted Production

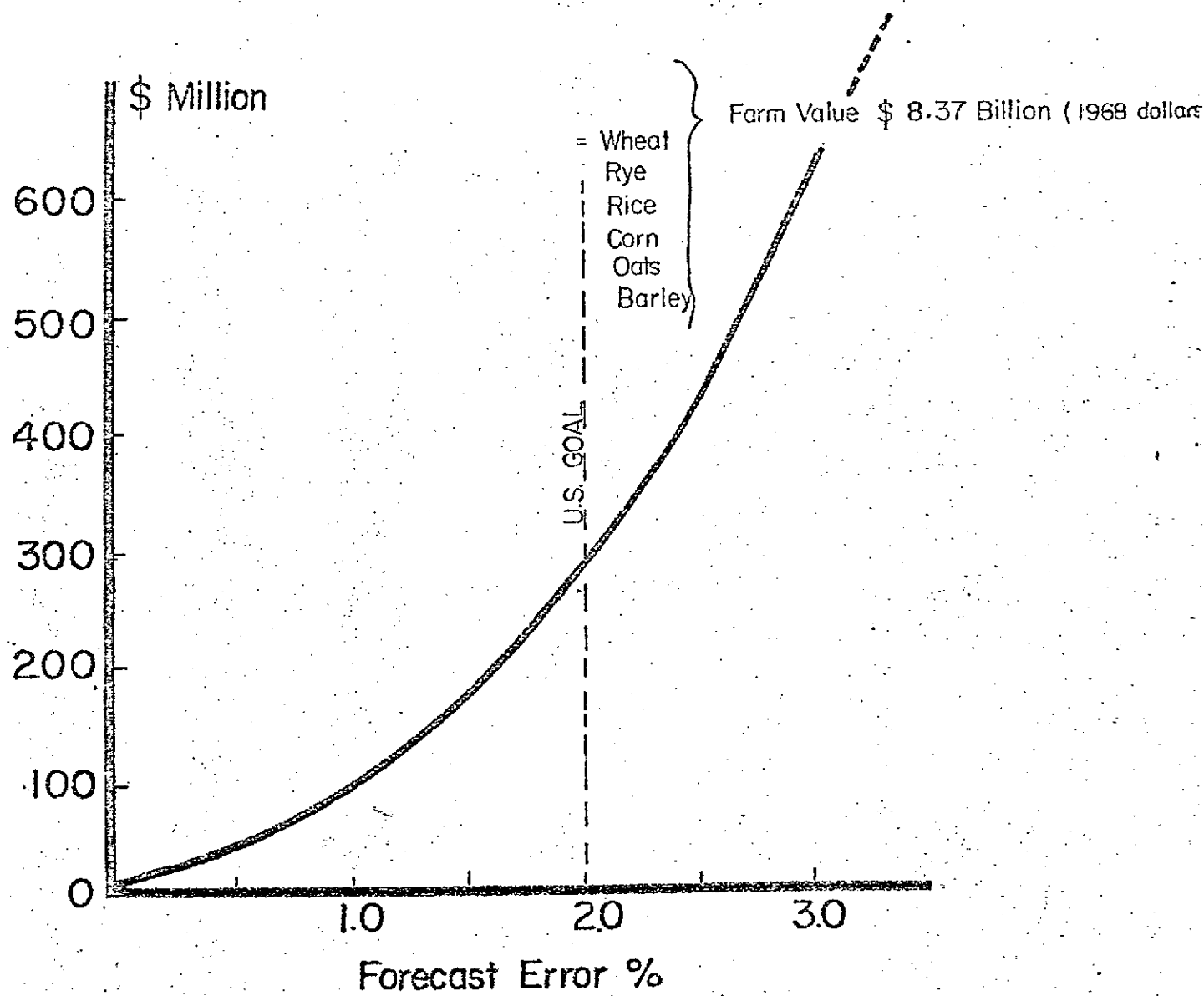
OP' = Price corresponding to estimated production OQ'

QQ" = Quantity carried over to next year

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

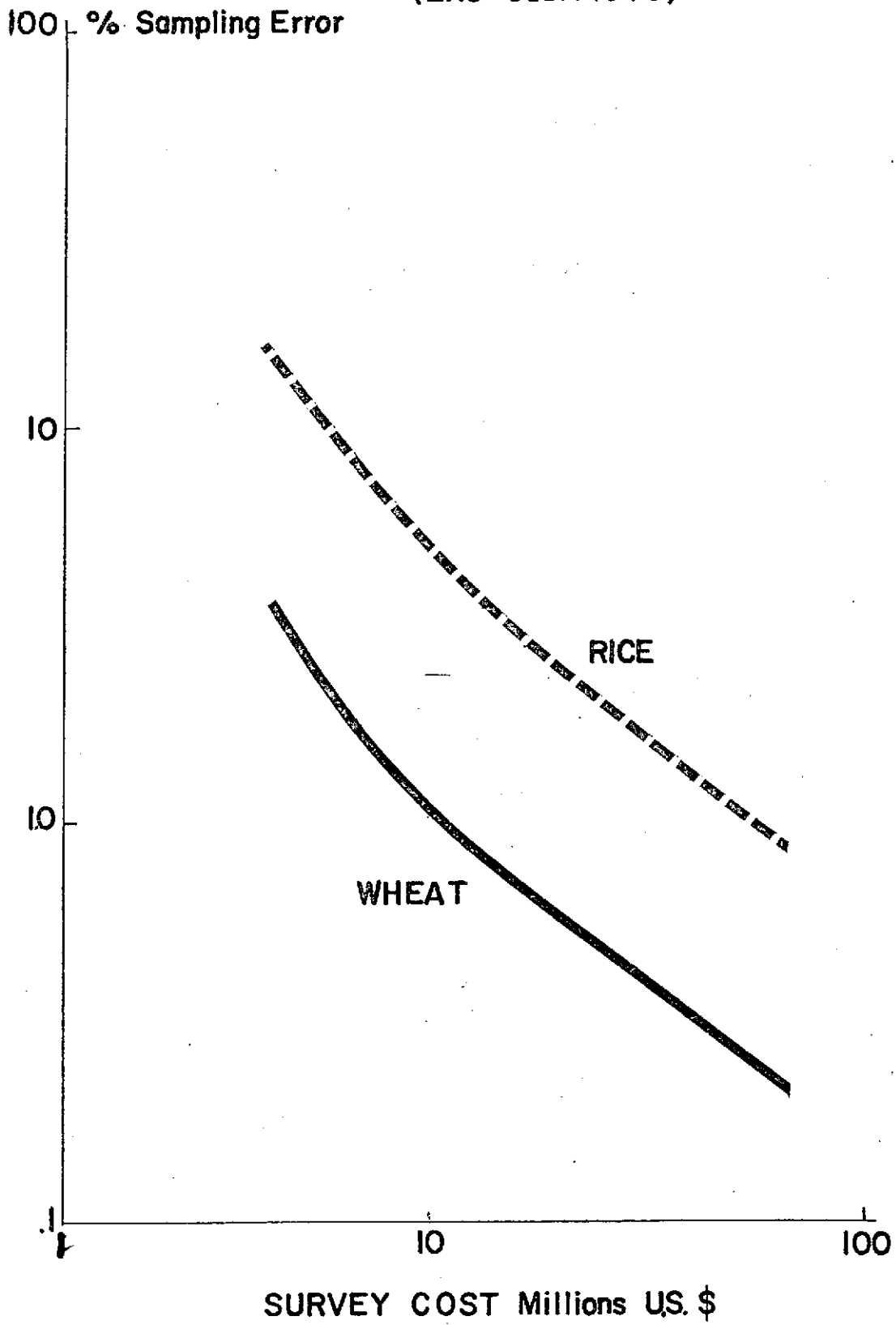
BASIC STRUCTURE OF HAYAMI -PETERSON ECONOMIC MODEL

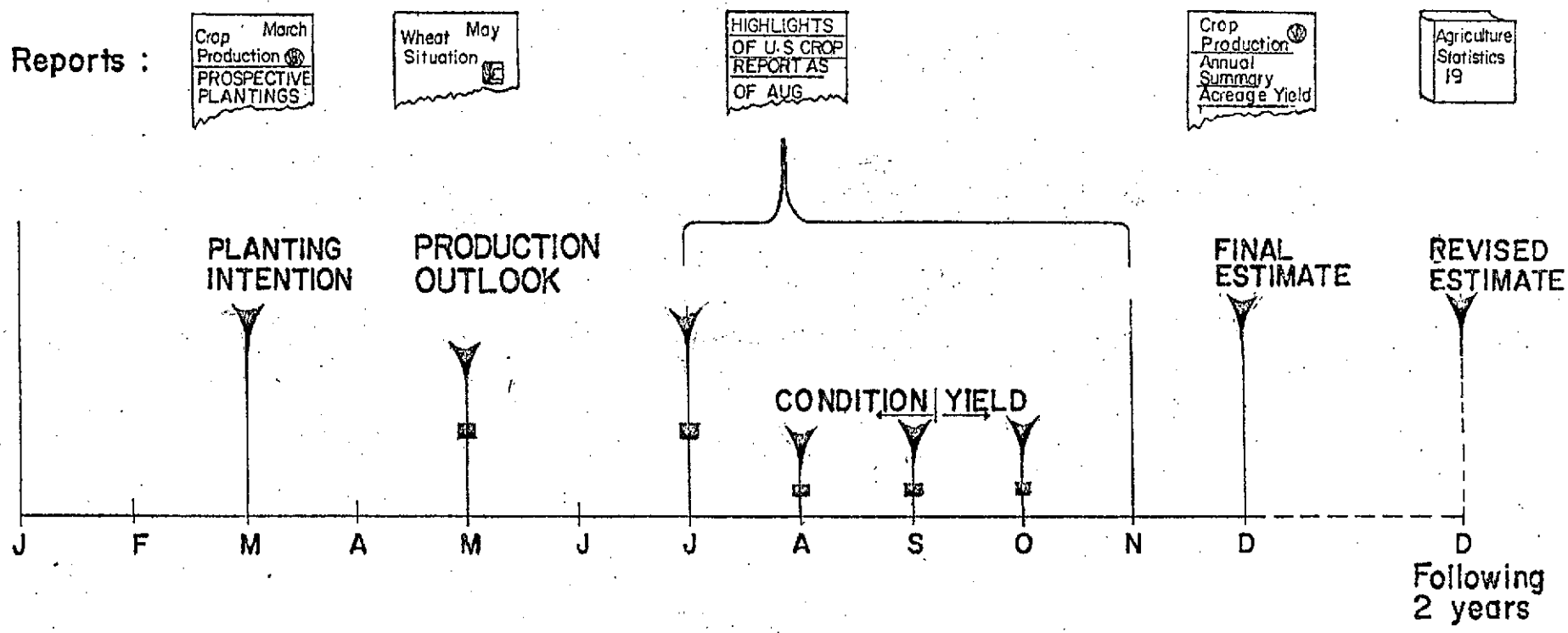
LOSS DUE TO CROP FORECAST ERROR
(U.S. grain crops after Hayami Peterson)



COST OF SAMPLE SURVEY FOR VARIOUS SAMPLING ERROR LEVELS

(ERS-USDA 1970)

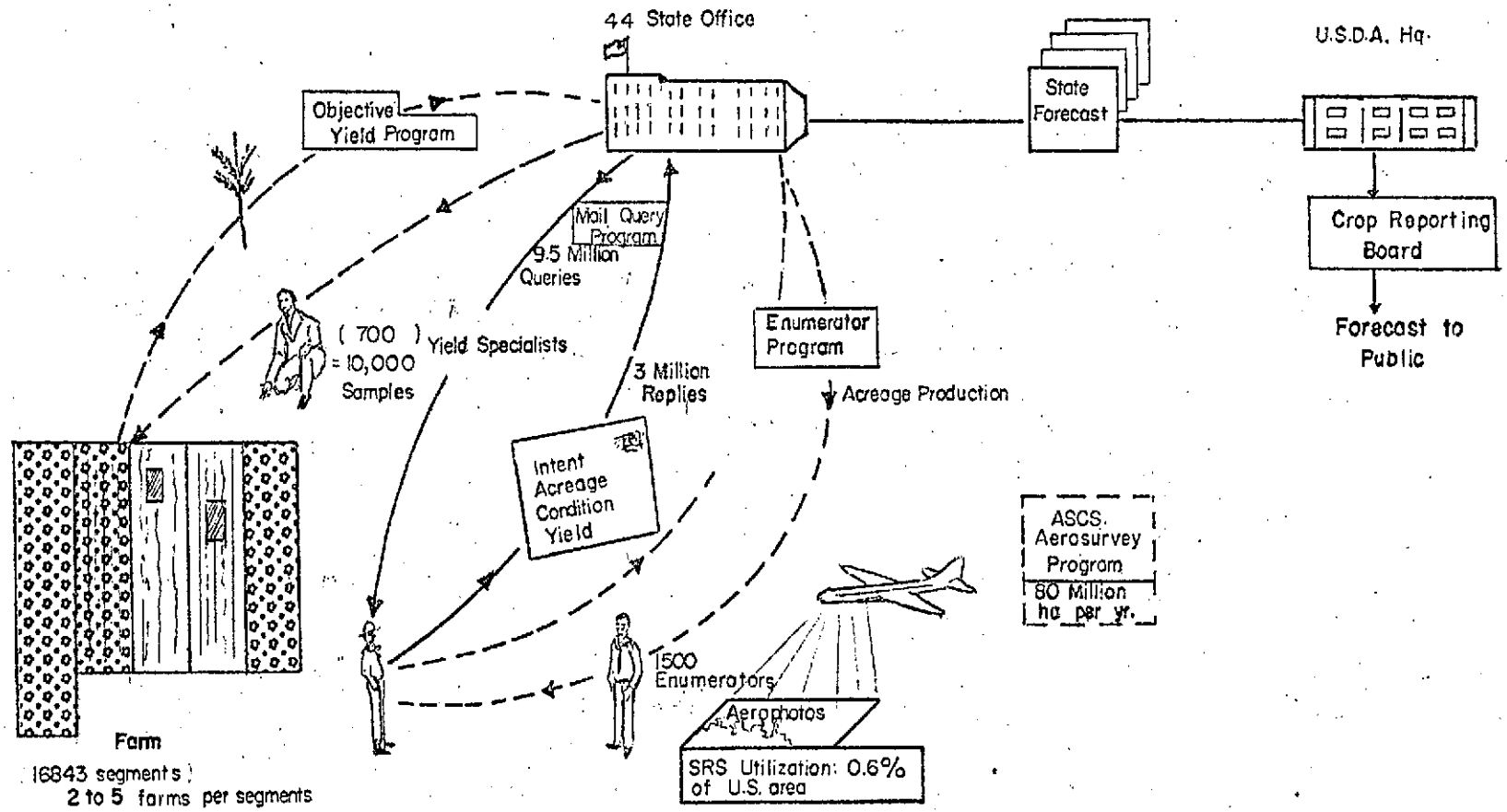




TYPICAL USDA (CORN, WHEAT) FORECAST AND FORECAST RELEASE CYCLE

= 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 ------ ACRES THIS YEAR	------
REPORT FOR YOUR LOCALITY:	
ACRES FOR HARVEST THIS YEAR COMPARED WITH ACRES HARVESTED LAST YEAR ---------- %	------
CONDITION OF CORN ------- %	------
PROBABLE YIELD/ACRE ------ BU.	---

ANS ----------

ED ABOVE (INCLUDE ----------

ACRES OF ALL LAND IN THIS FARM (INCLUDE LAND RENTED) ----------

NAME ----------

ADDRESS ----------

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 BUSHELS	
CORN ON THIS FARM JAN 1, 1974 70 LB. EAR OR 56 LB. SHELLED BUSHELS	
ALL WHEAT PRODUCED ON THIS FARM LAST YEAR - 60 LB. BUSHELS	
ALL WHEAT ON THIS FARM JAN 1, 1974 60 LB. BUSHELS	

TYPICAL REPORT FORMATS, U.S. FARMERS

USDA FORECAST MODEL, GRAINS

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

WHERE:

P = ESTIMATED PRODUCTION (BUSHELS)

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

Country	SURVEY CLASSIFICATION Acreage Forecast	Yield Forecast	Statistical Sampling
EUROPE			
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
NORTH-CENTRAL AMERICA			
Canada	A	A	S
Costa Rica	A	A*	S
Dominican Republic	A	A	--
El Salvador	B	B	--

Country	SURVEY CLASSIFICATION Acreage Forecast	Yield Forecast	Statistical Sampling
Guadalope	B	B	--
Guatemala	A	A*	--
Martinique	B	B	--
Mexico	B	B	--
Panama	A	A*	S
Puerto Rico	A	A*	S
USA	A	A	S
SOUTH AMERICA			
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	--
ASIA			
Burma	A	A	--
Ceylon	A	B	S
Cyprus	A	A*	--

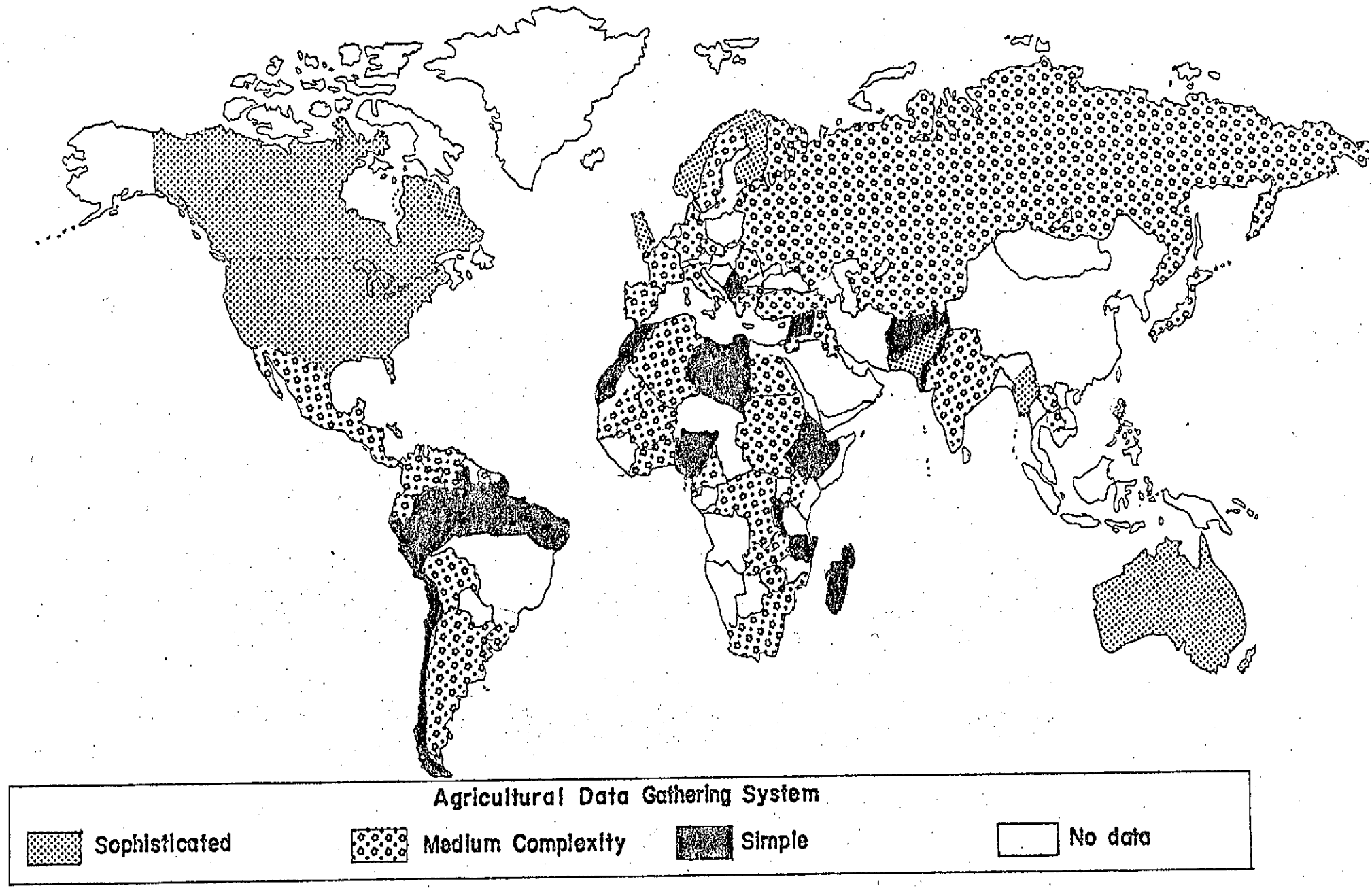
Country	SURVEY CLASSIFICATION Acreage Forecast	Yield Forecast	Statistical Sampling
Malaya	A	A*	S
India	A	B	--
Indonesia	B	A	--
Iran	D	D	--
Iraq	C	C	--
Israel	B	B	S*
Japan	A	B	S
Jordan	C	C	--
Lebanon	C	C	--
Pakistan	C	C	--
Phillipines	B	B	--
Syria	C	C	--
Thailand	B	B	--
Turkey	B	B	S
AFRICA			
Algeria	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	--

Country	SURVEY CLASSIFICATION 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	--
Madascar	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 Af	A	A	--
Uganda	C	C	S*
OCEANIA			
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

	Developing	Intermediate	Advanced
	Typical: Dominican Republic	Typical: Italy	Typical: United States of America
Regional Administrative Structure	1599 sections grouped into 69 ommunes	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	• Interview of producers by enumerators	• Crop area from personal judgement, supplemented by cadastral survey • Crop yields from local inquiry	• Direct inquiry to farmer respondents • Enumerators with aerial photos • Objective yield measurement by specialists
Sampling Structure	None	Simple sampling procedure	Multi-frame stratified sampling procedures
Organization	Municipal Statistical Board in each commune	• Data from commune collected by local correspondent assisted by provincial agricultural inspector • Central Institute of Statistics issues technical directives and publishes results	• SRS HQ staff supported by 44 State offices comprising 9 crop regions. • Refer to Figure 9
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.



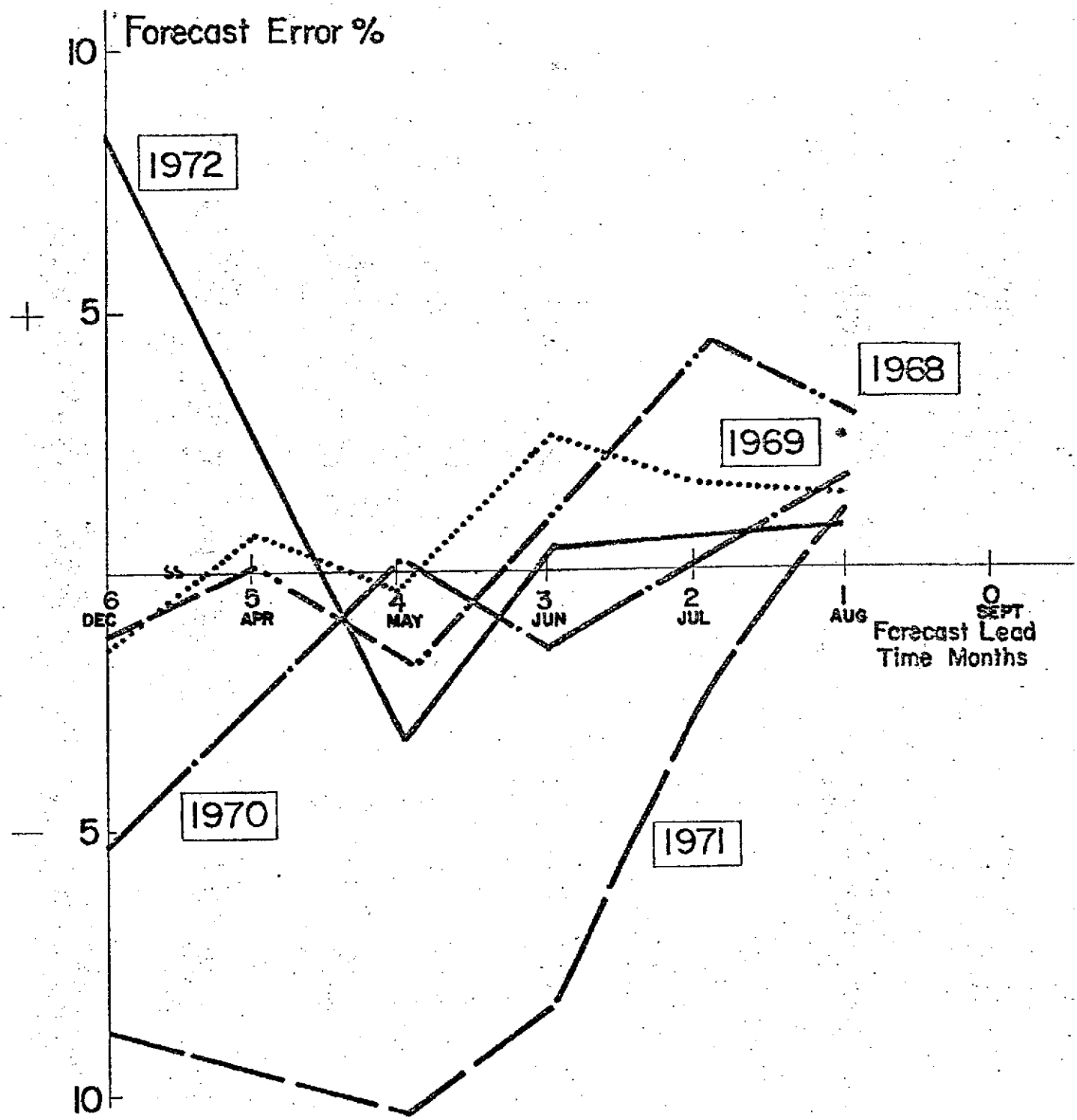
Distribution of Crop Forecasting Activities

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
WORLD			104.2

PUBLISHED USDA-SRS FORECAST ACCURACY

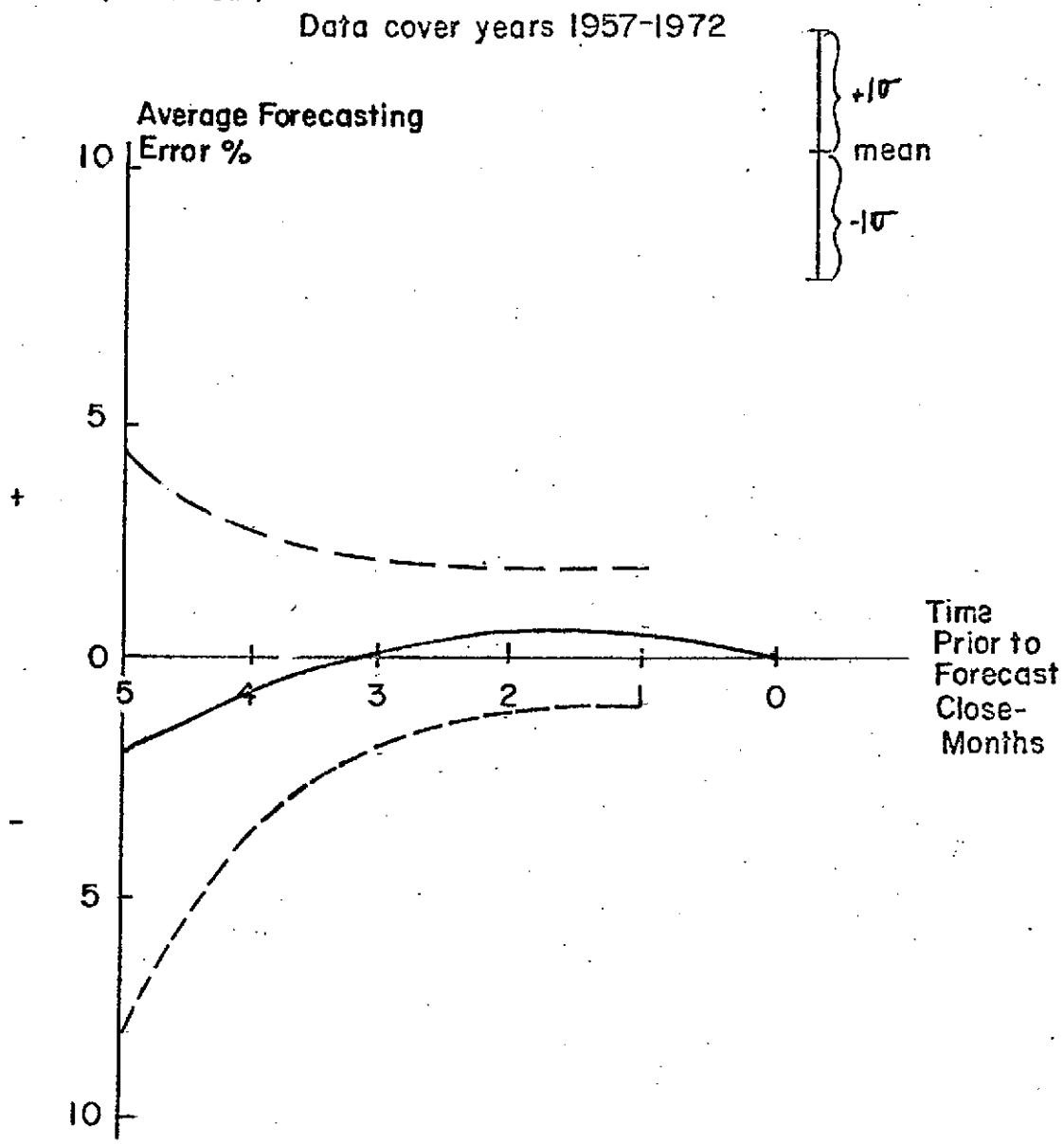
WINTER WHEAT - TOTAL U.S. CROP



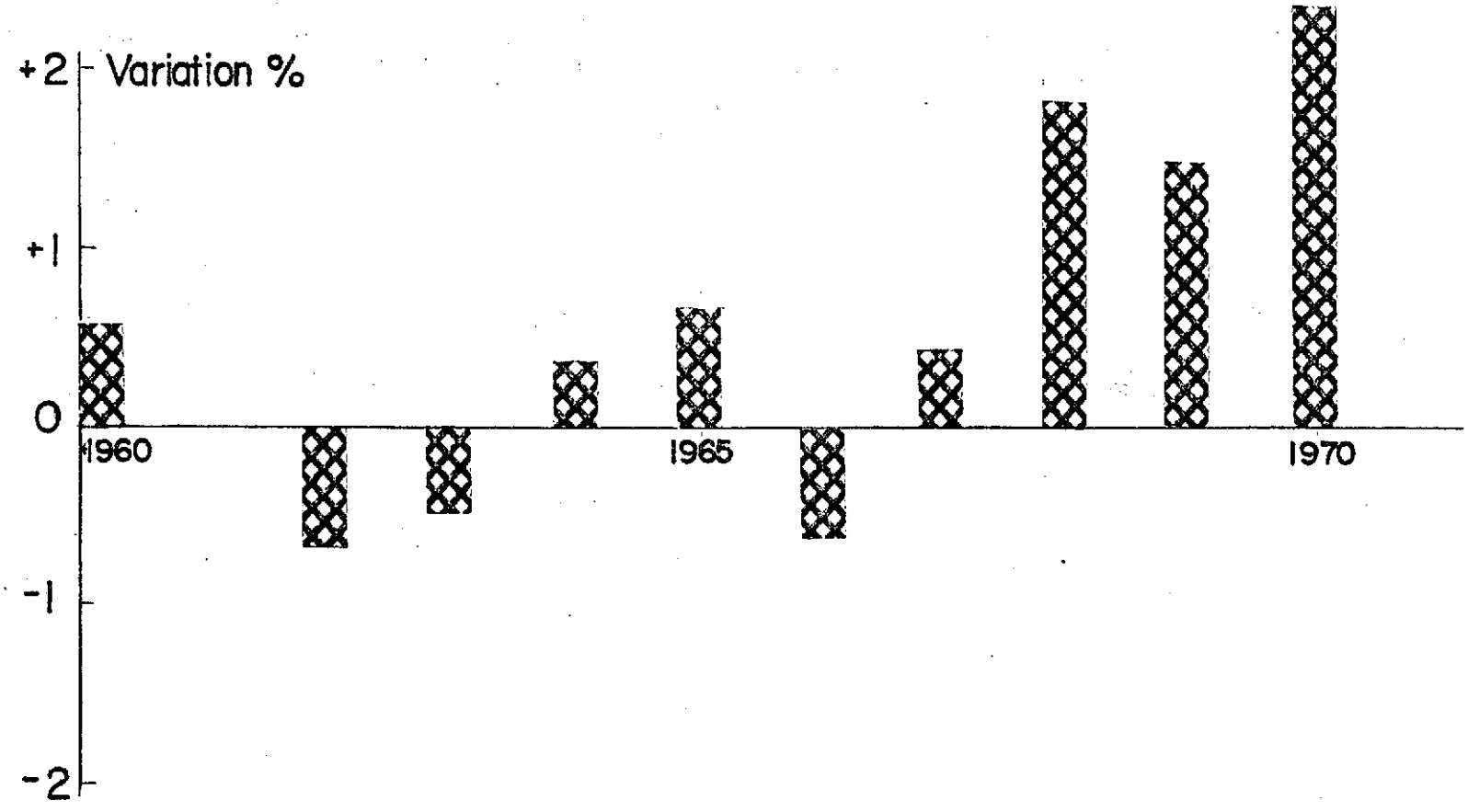
USDA-SRS Average Crop Forecasting Error Versus Time Prior to Crop Year Close

(All Wheat)

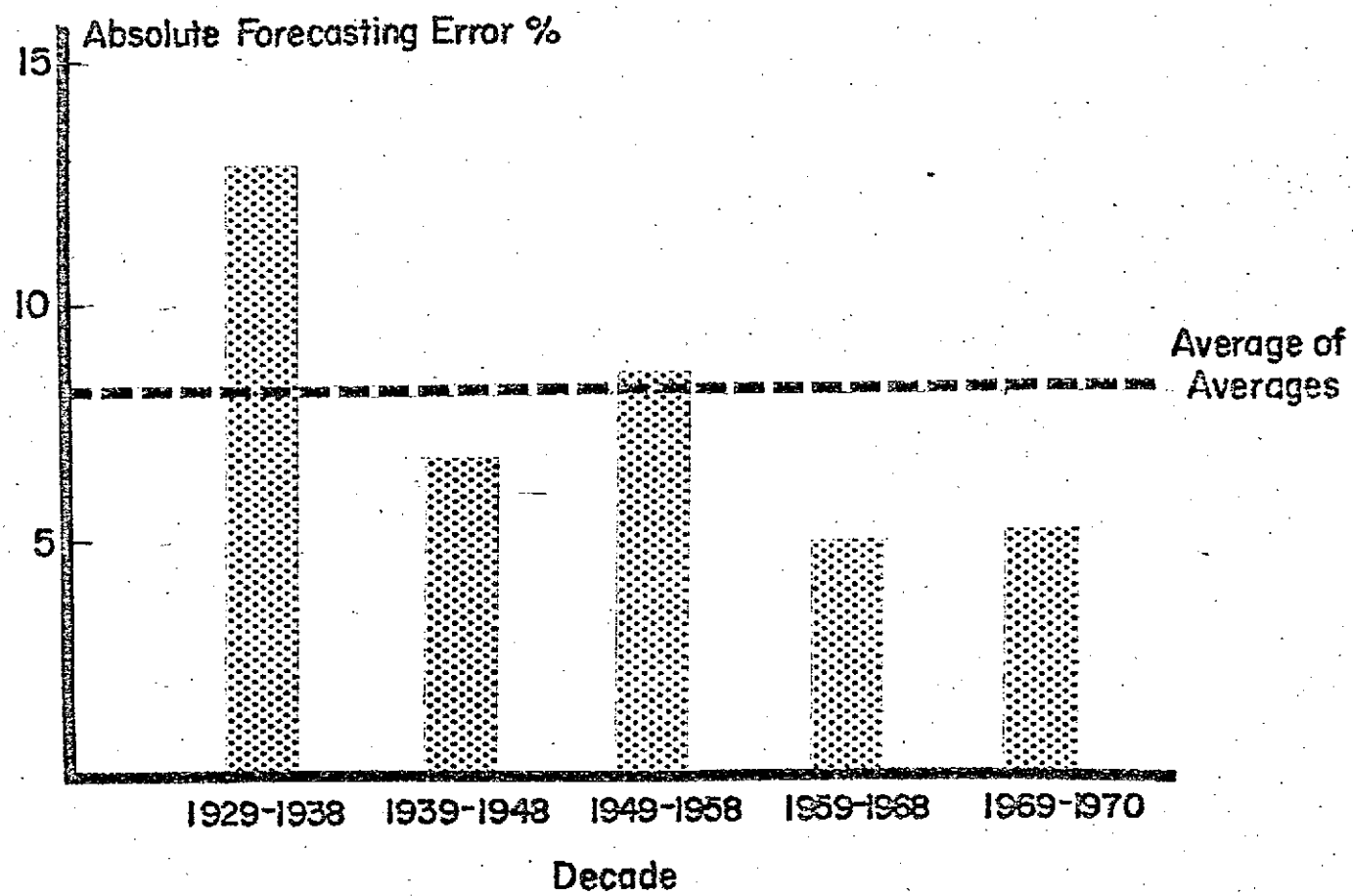
Data cover years 1957-1972



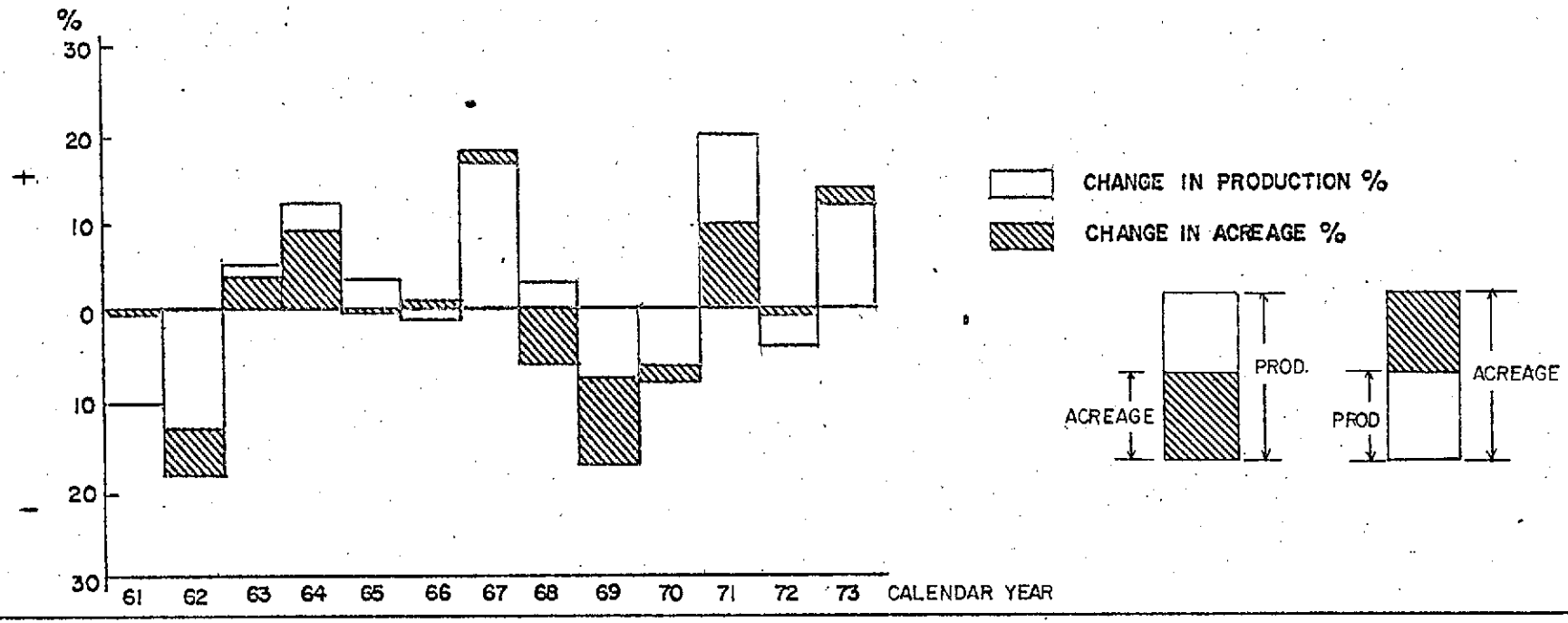
VARIATION BETWEEN PRELIMINARY AND FINAL WINTER WHEAT ESTIMATE



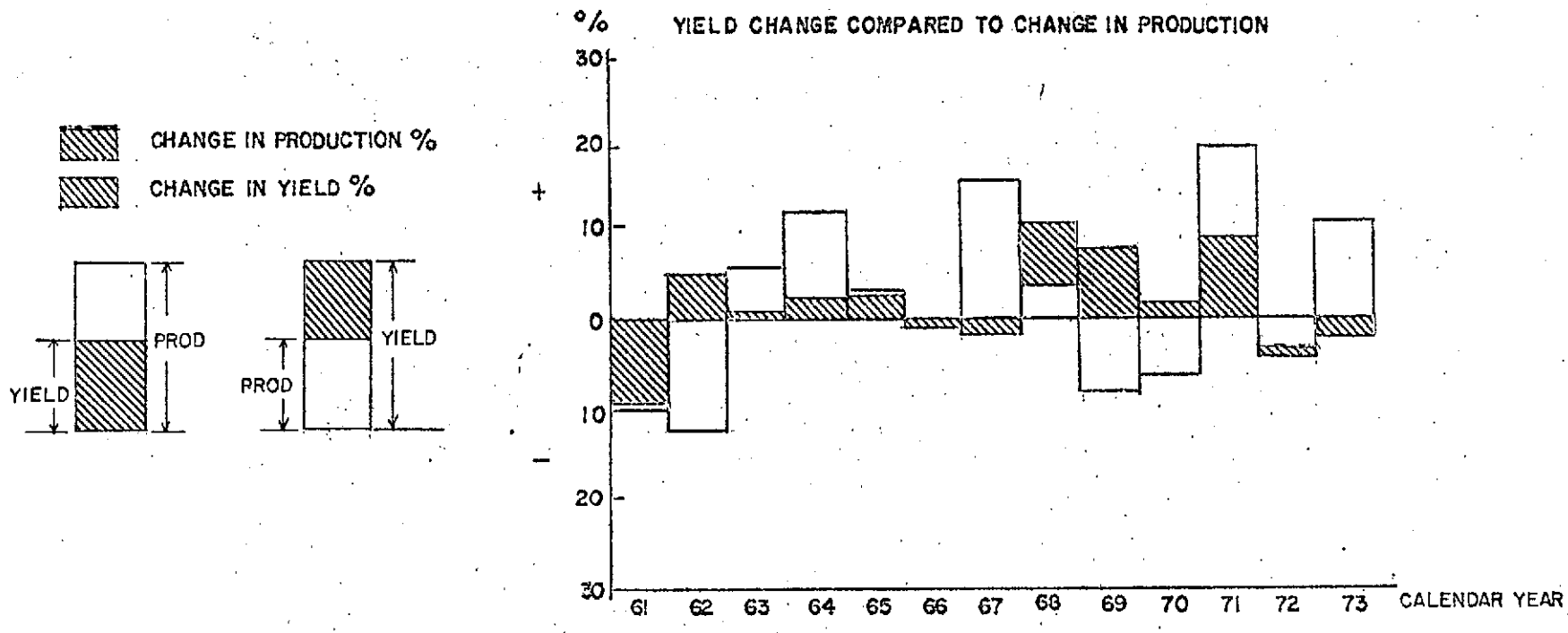
TREND OF AVERAGE USDA FORECASTING ERRORS
(major commodities)



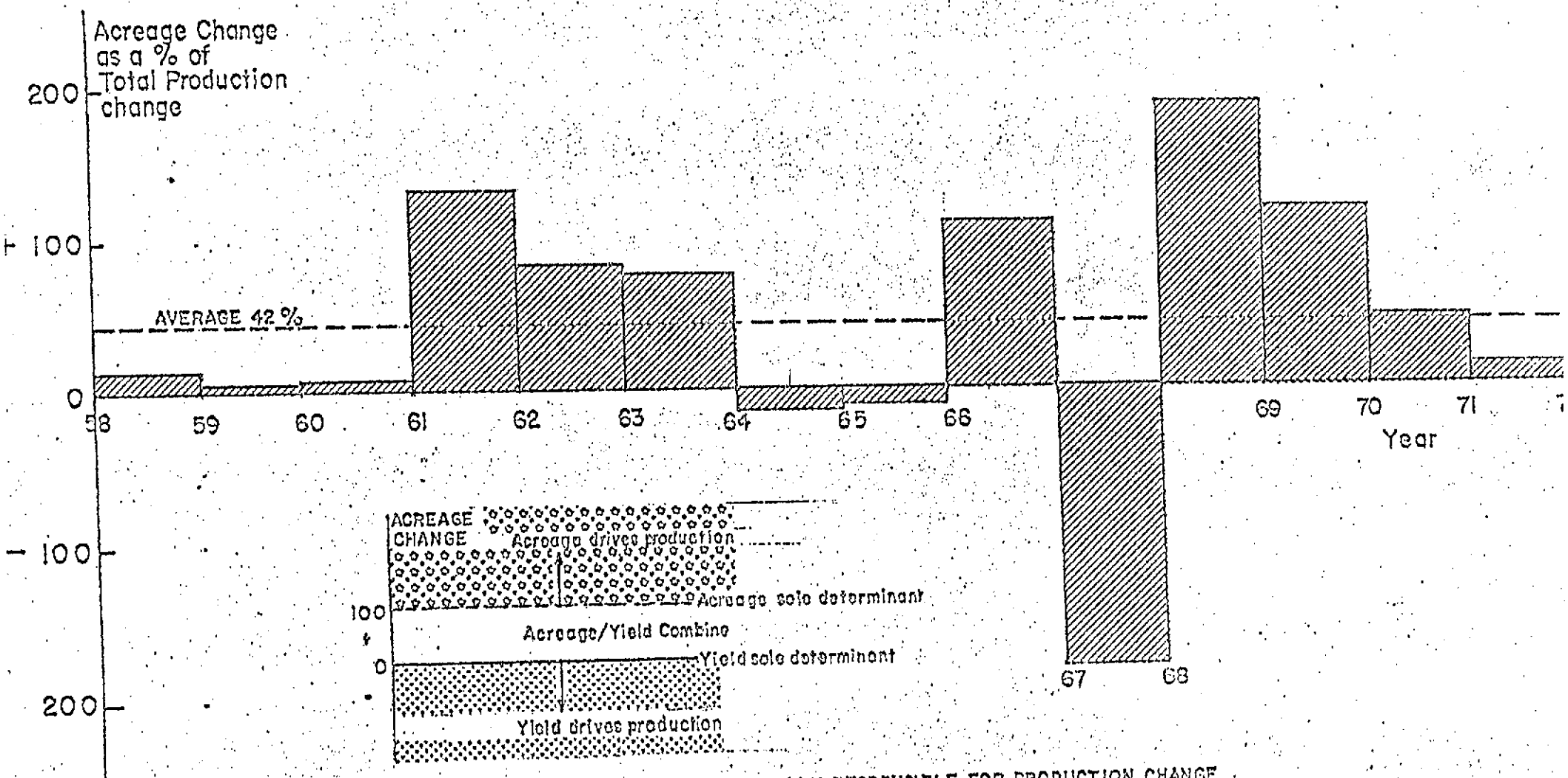
THE EFFECT OF CHANGES IN ACREAGE YIELD
ON TOTAL PRODUCTION OF WHEAT



YIELD CHANGE COMPARED TO CHANGE IN PRODUCTION

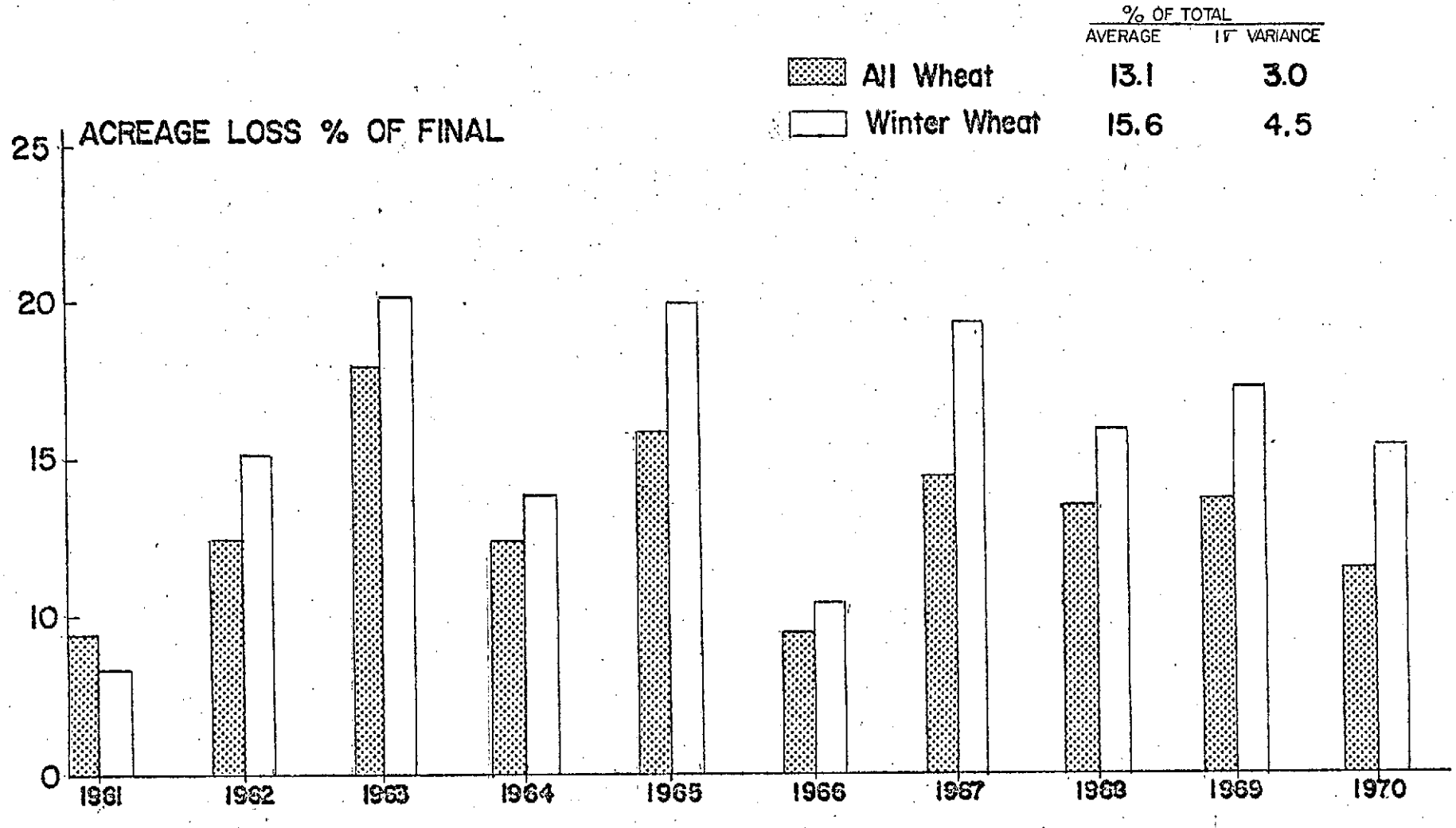


CONTRIBUTION OF ACREAGE HARVESTED TO TOTAL WHEAT PRODUCTION



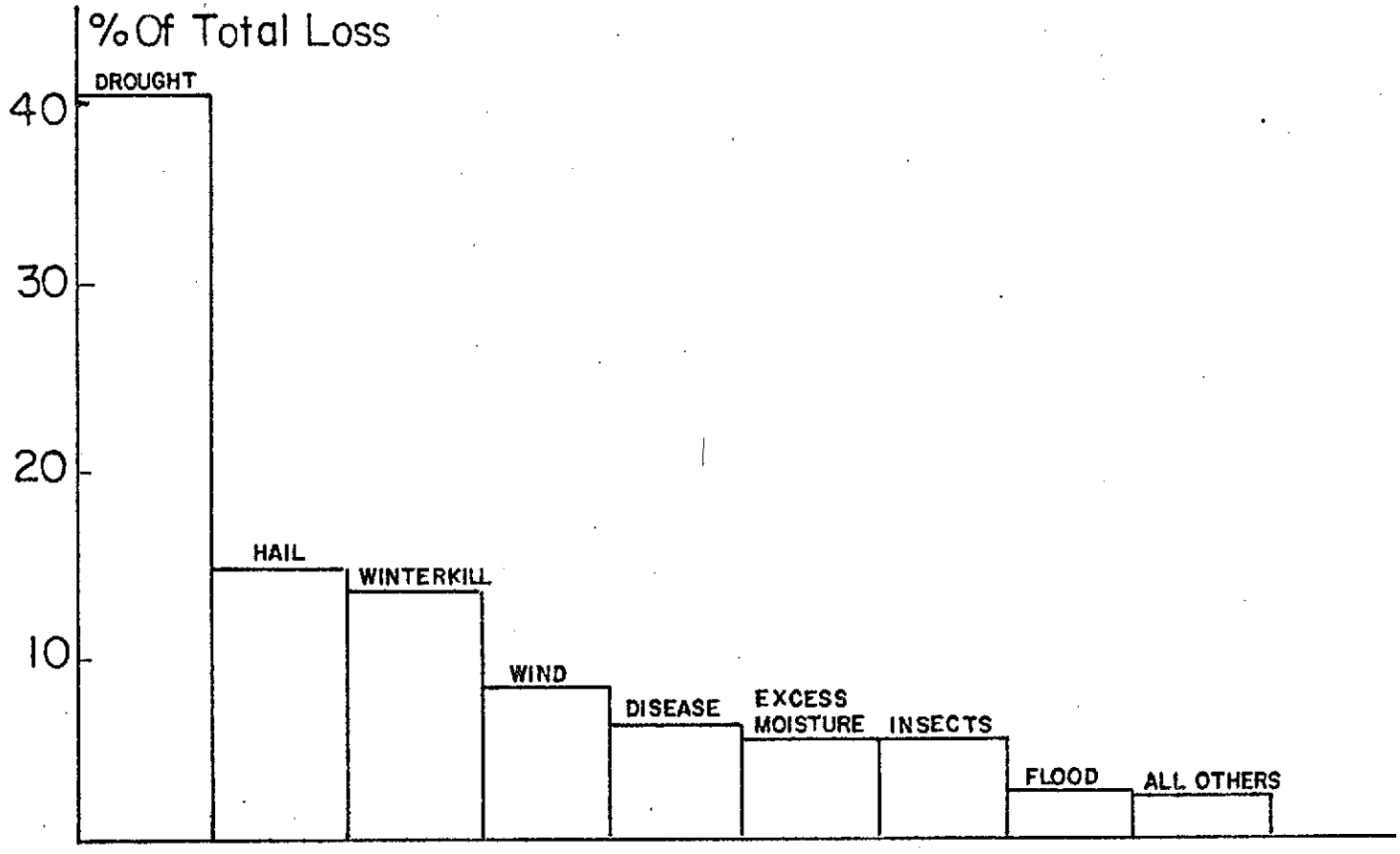
KEY: +100% MEANS ACREAGE CHANGE WAS FULLY RESPONSIBLE FOR PRODUCTION CHANGE
>+100% " " " WAS GREATER THAN PRODUCTION CHANGE (YIELD DIMINISHED)
0% " " " DID NOT INFLUENCE PRODUCTION CHANGE
-VALUES " " VARIED OPPOSITELY TO PRODUCTION CHANGE

ACREAGE LOST IN U.S. DURING GROWING SEASON

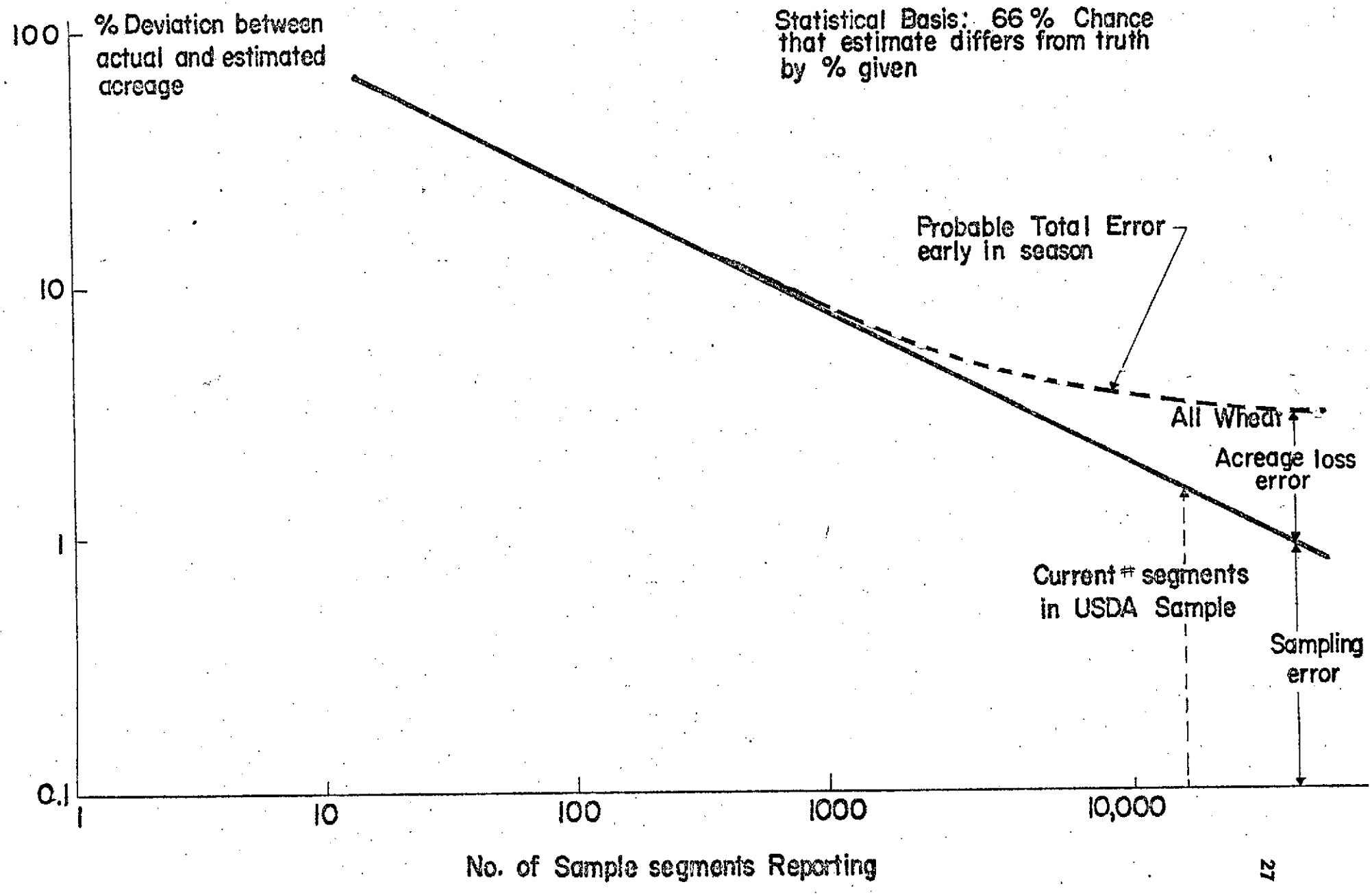


	% OF TOTAL AVERAGE	% OF TOTAL 1σ VARIANCE
All Wheat	13.1	3.0
Winter Wheat	15.6	4.5

CROP LOSS CAUSES: WHEAT
(1939-69)



ACREAGE MEASUREMENT ACCURACY BY USDA SAMPLING PROCEDURE

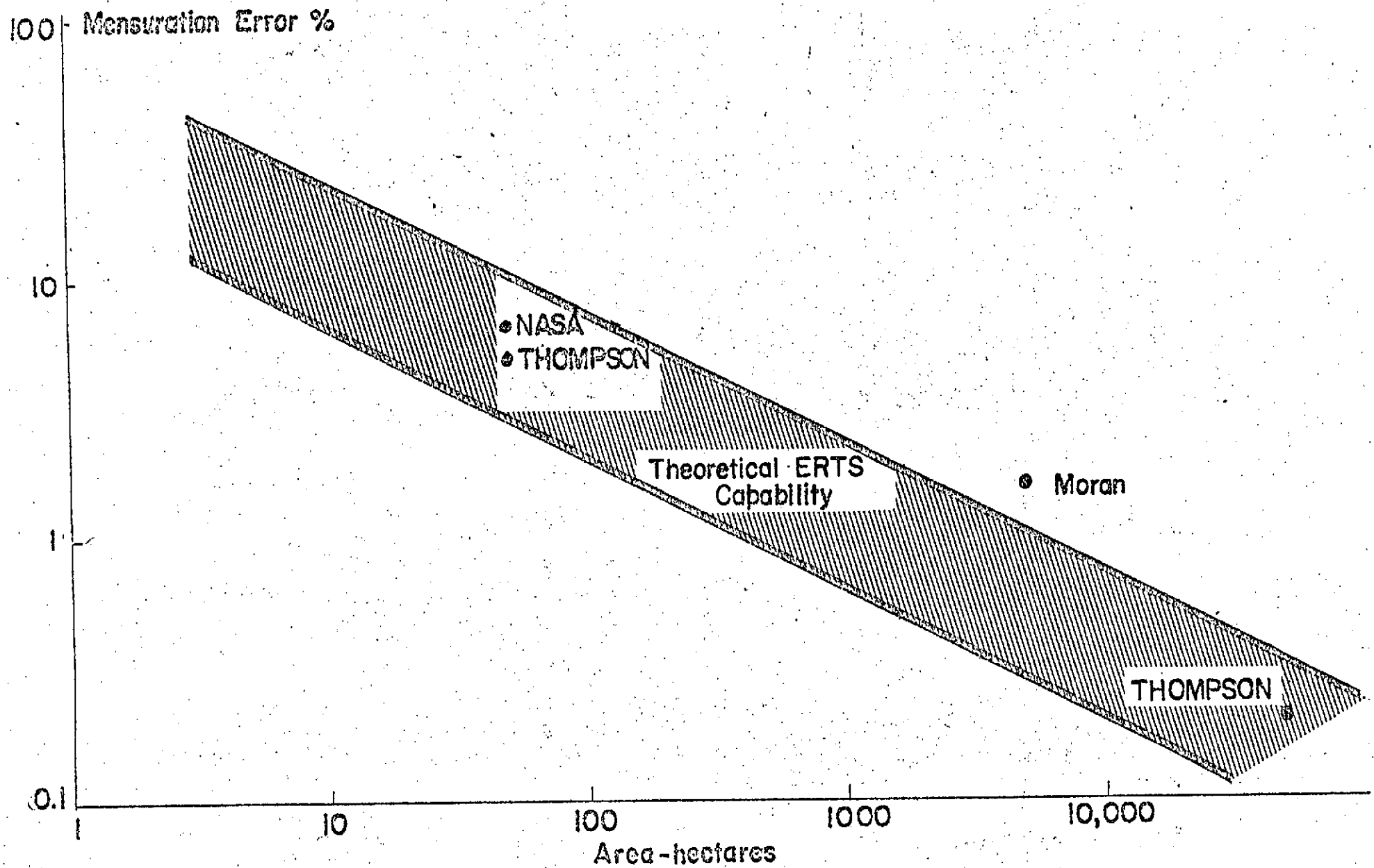


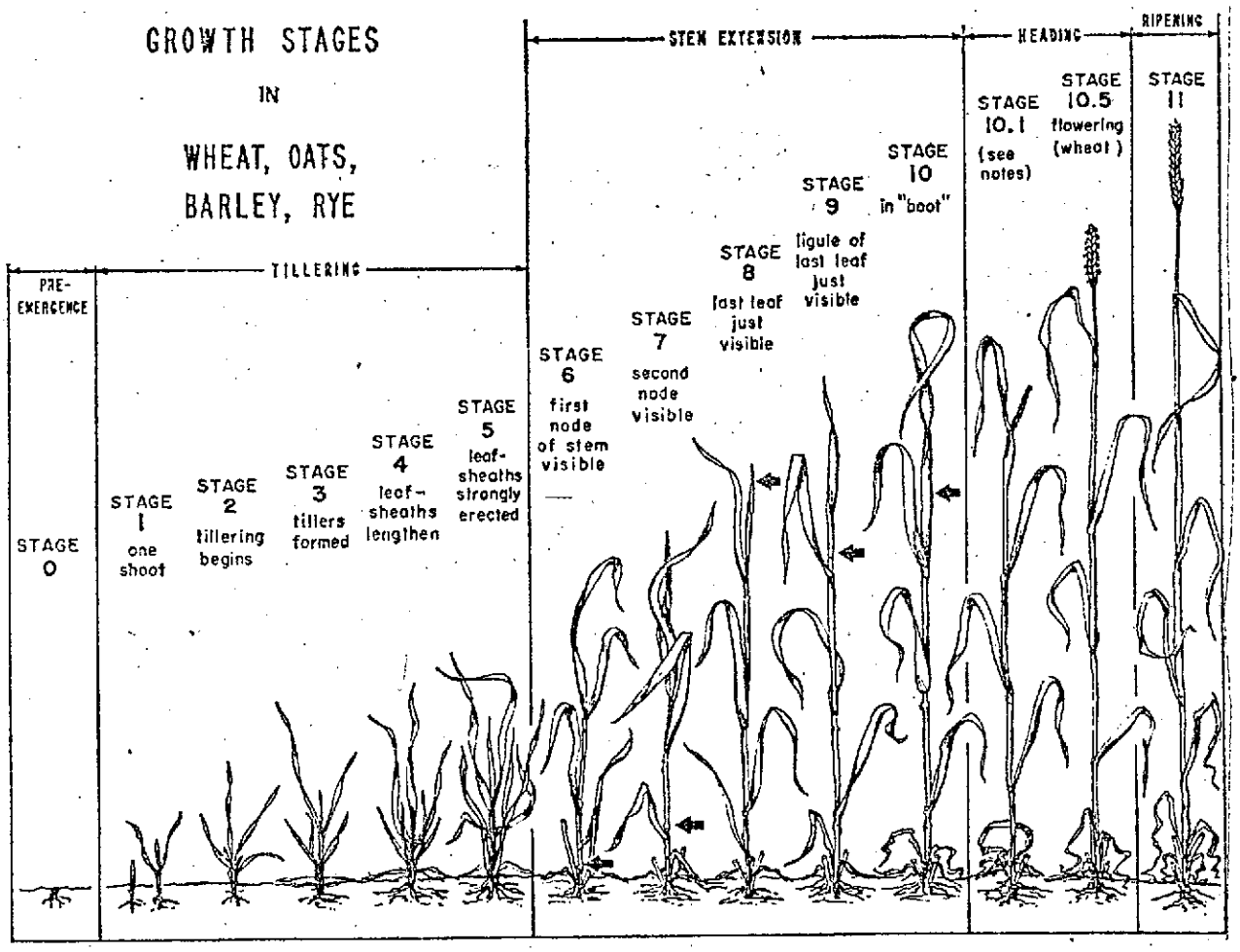
ACCURACY OF REMOTELY SENSED CROP DISCRIMINATION

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

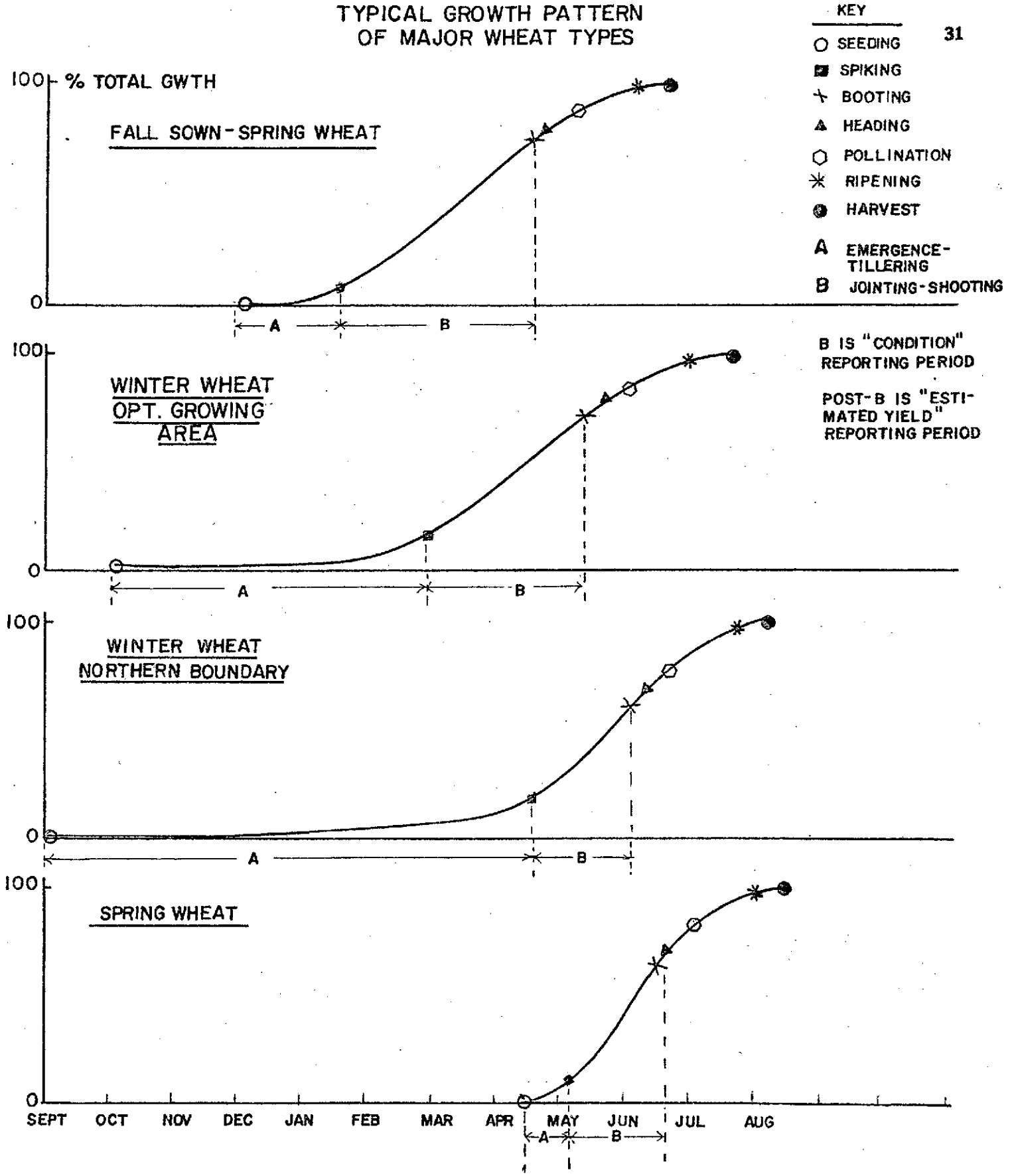
--- = not available

COMPARISON OF ERTS RESULTS TO THEORETICAL MENSURATION ERROR

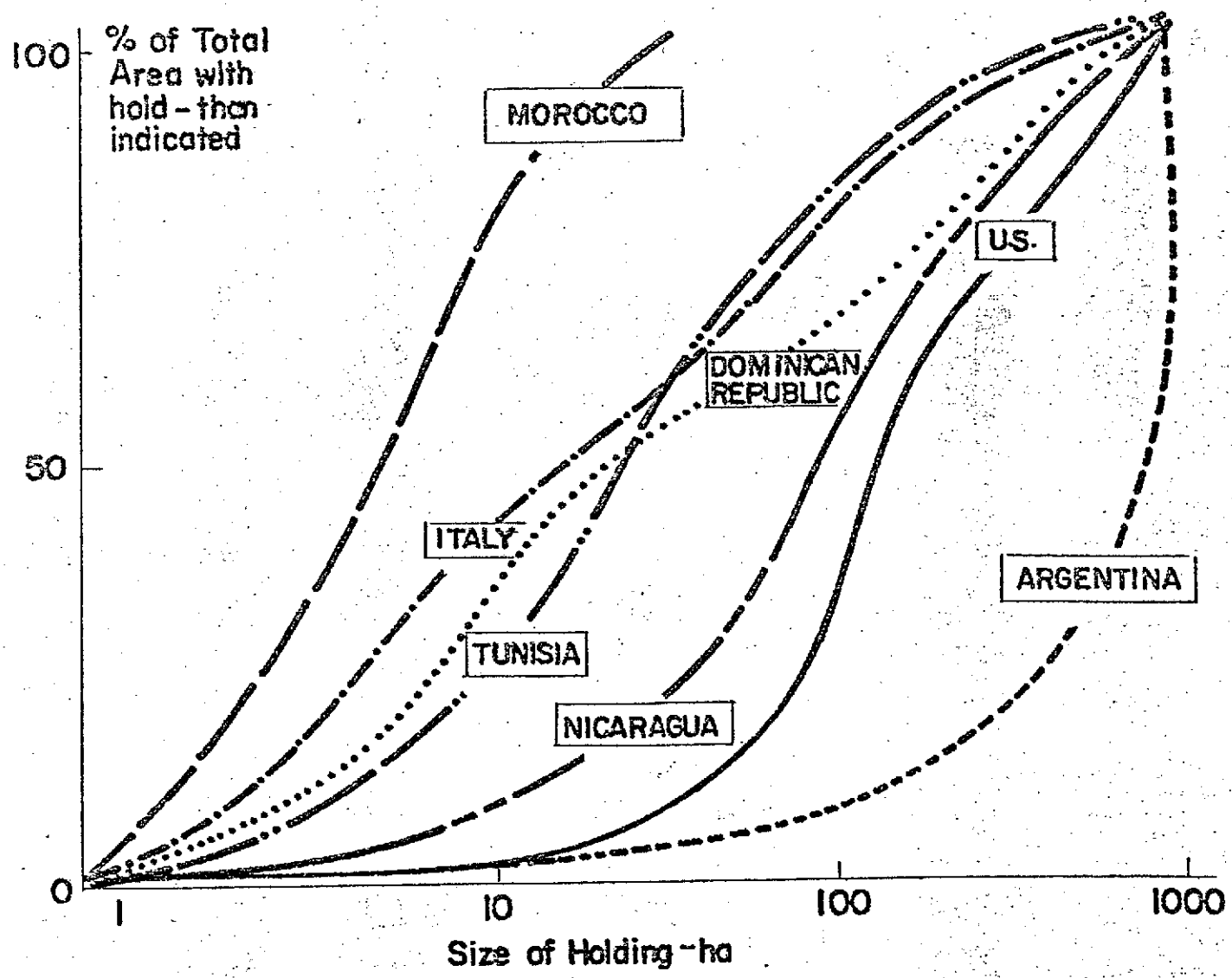



GROWTH STAGES
IN
WHEAT, OATS,
BARLEY, RYE
PRE-EMERGENCE
TILLERING
STEM EXTENSION
HEADING
RIPENING
STAGE 0
STAGE 1 one shoot
STAGE 2 tillering begins
STAGE 3 tillers formed
STAGE 4 leaf-sheaths lengthen
STAGE 5 leaf-sheaths strongly erected
STAGE 6 first node of stem visible
STAGE 7 second node visible
STAGE 8 last leaf just visible
STAGE 9 ligule of last leaf just visible
STAGE 10 in "boot"
STAGE 10.1 (see notes)
STAGE 10.5 flowering (wheat)
STAGE 11

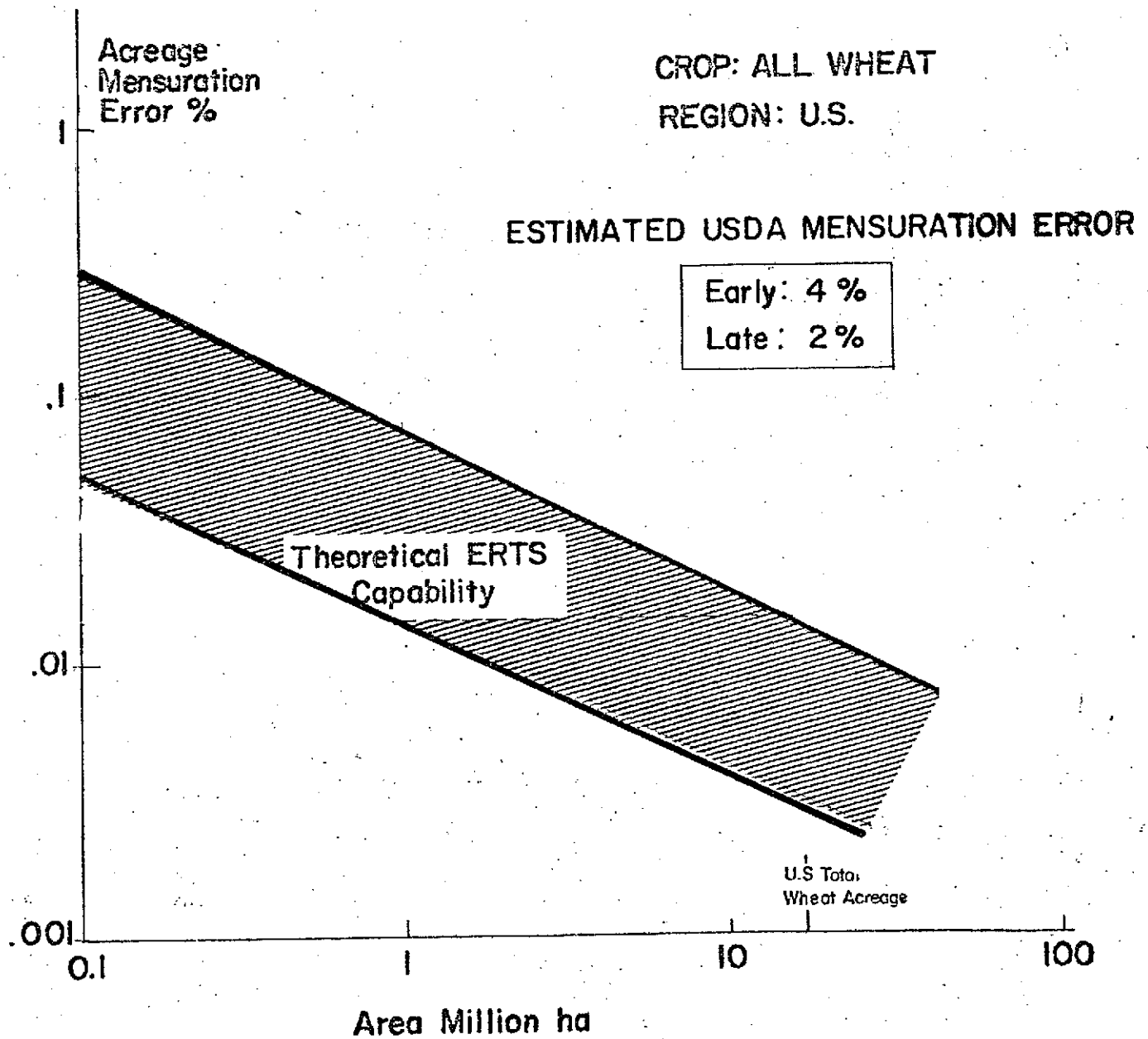
TYPICAL GROWTH PATTERN OF MAJOR WHEAT TYPES



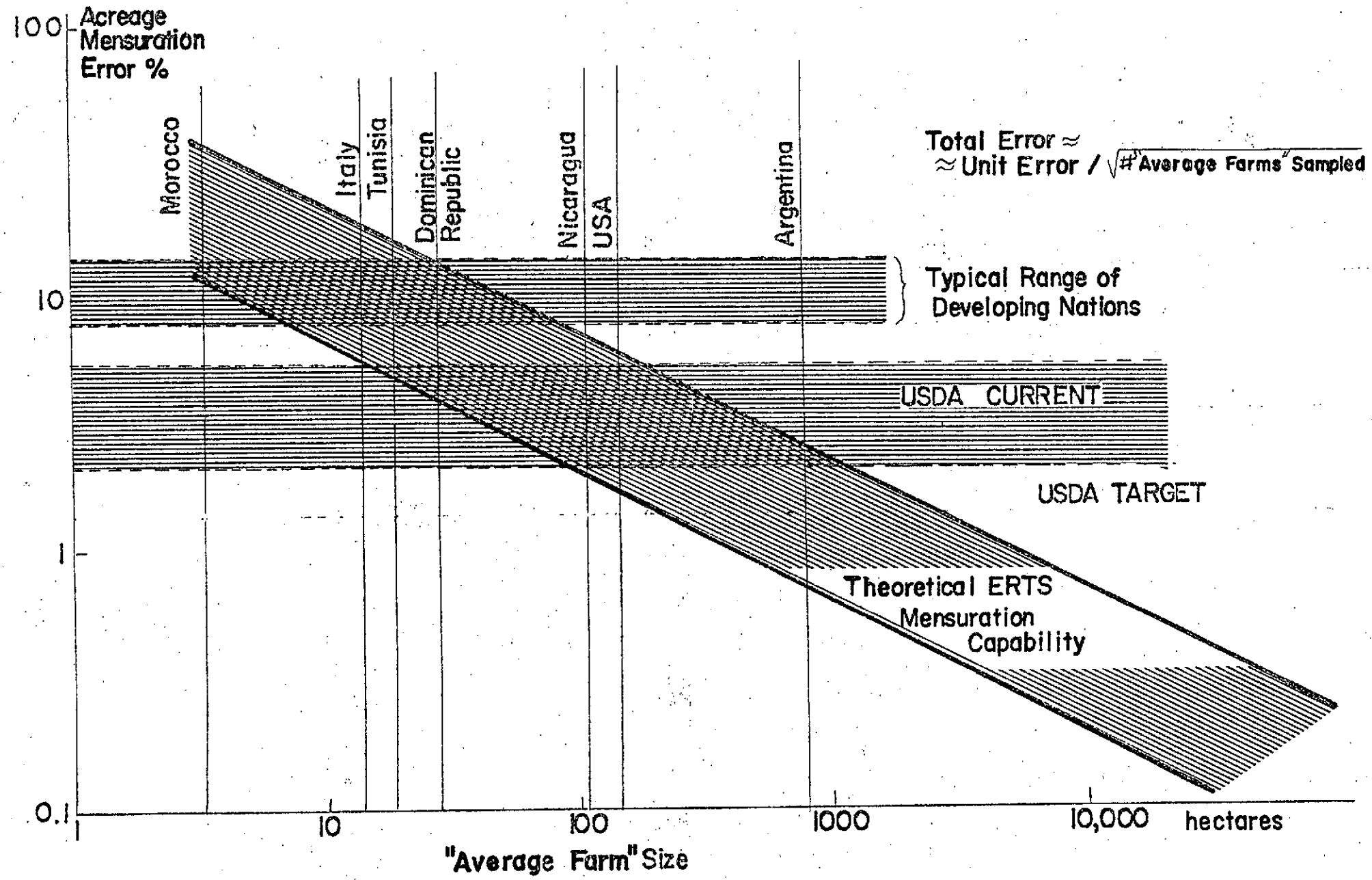
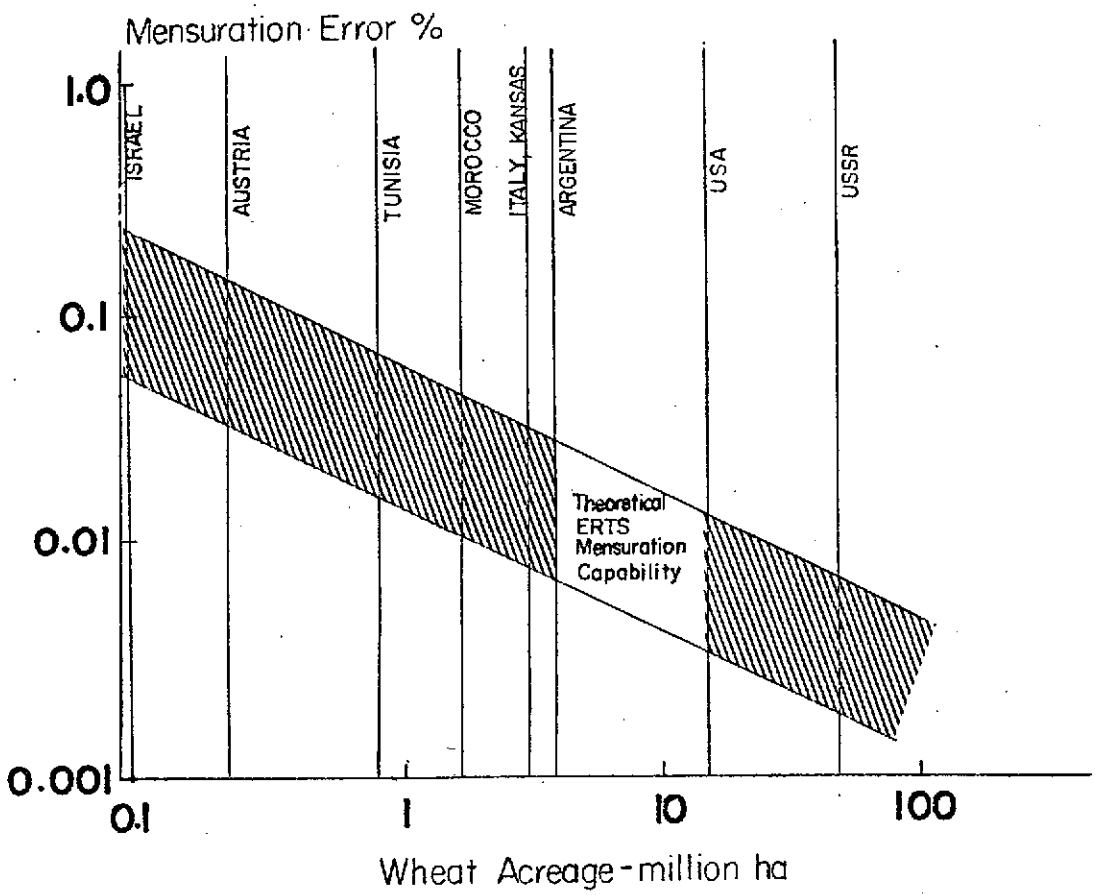
CROP AREA DISTRIBUTION



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