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THE DYNAMICS OF LOCATION: A VON THUNEN-SUPPLY ANALYSIS OF THE CHANGING SPATIAL CHARACTERISTICS OF COTTON IN UGANDA

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ABSTRACT

With the increasing popularity of regional and district planning, there is growing necessity to infuse a spatial dimension in economic analysis of African development phenomena. This paper is an attempt to intergrate the Economic Geography of one Location theory (Von Thunen) with the economic statistical analysis of supply to explain the dramatic changes in the agricultural landscape in Uganda that is increasingly showing a relocation of cotton out of its trditional habitat, Central Uganda.

INTRODUCTION

Cotton is by far the most widely grown traditional cash crop in Uganda. As fig. 1 will show, it grows in every district except Kigezi in the south west and Karamoja in the north east. It is also the second major domestic export and is by far a more important absorber of agricultural labor than any other cash crop.

Looking at time series data on land use and physical output in the cotton industry, one observes an interesting phenomenon with respect to the spatial distribution of the crop. It is interesting to note that before the second world war and in the immediate postwar years, two thirds of the cotton crop was produced in central Uganda (Buganda) and only one third was produced in Eastern and Northern Uganda. Since the 1950's, the focus of cotton growing has shifted northwards and eastwards. As a glance at table 1 will show, acreage in the Eastern region almost doubled between 1950 and 1966 and in general, all regions experienced a great increase in acreage except Buganda where it has actually declined steadily.

A second and related interesting phenomenon is the declining level of total output currently being experienced in the industry. Although the target production under President Amin's "Double Production Campaign" and "Economic War" policies has been set at 500,000 bales, oral evidence gathered from Lint Marketing Board officials in the Mombasa office revealed that production in 1974 will hardly reach the 300,000 bales mark. This is in contrast with the 410,000 bale production level attained previously.

The foregoing two phenomena reflect changing economic interrelationships between various outputs on the multi-product peasant farms and between various spatial points in the country. A casual inspection of the data in table 1 shows that these changes are more dramatically manifest in Buganda (column 5). The object of this paper is to utilise the acreage data in tables 1 and 3 apply certain tools of supply and location analysis to explain some of the major changing inter crop relationships on the cotton farms as well as the changing locational characteristics of the cotton crop in Uganda.

The Framework for Spatial Analysis

In this exercise, we shall use "regions" as our units of analysis Conceptually, a region is an intermediate category between an aggregate economy with no Spatial dimension and a highly disaggregated economic system defined as a set of spatial points. The region is not as disaggregated as the

Table 1

ACREAGE AND PRICE DATA

t	X_1	X_2	X_3	X_4	PC
1945	55400	28000	137000	428,000	17
1946	63400	24000	185000	469000	18
1947	524000	28000	187000	298000	20
1948	768000	44000	267000	477000	22
1949	696000	42000	364000	526000	30
1950	656000	58000	312000	506000	33
1951	779000	56000	262000	416000	45
1952	805000	53000	273000	342000	50
1953	867000	57000	284000	398000	50
1954	904000	66000	337000	432000	51
1955	883000	62000	267000	374000	51
1956	892000	53000	277000	346000	55
1957	875000	78000	316000	348000	56
1958	1229000	90000	410000	384000	58
1959	857000	92000	291000	325000	47
1960	825000	86000	443000	278000	48
1961	1084000	86000	443000	278000	55
1962	1062000	71000	393000	459000	57
1963	1189000	80000	484000	278000	57
1964	1278000	95000	473000	281000	51
1965	1375000	93000	529000	293000	56
1966	1328000	100000	517000	223000	40

Source: Ministry of Agriculture, Entebbe, Revised Crop Acreages, The Government Printer 1960.

Ministry of Agriculture Annual Reports, The Government Printer (various issues)

X_1 = Acreage in Eastern Region

X_2 = Acreage in Western Region

X_3 = Acreage in Northern Region

X_4 = Acreage in Buganda

PC = Producer Price of cotton; Uganda cents per pound

set of spatial points and therefore allows a simplification in the analysis of spatial structure and of economic processes in space. It is expected that different types of economic activities take place in the space defined by the set of spatial points and these include production as well as consumption activities. The distribution of all these types of activities over all the elements of the set of spatial points yields what may be called an economic landscape. For any number of activities, the locational requirements of each can in principle be specified. But in practice, the specification for each activity is not independent of the specification for other activities. This means that if we started from a point of equilibrium, it would follow that the locational characteristics of the entire set are likely to change as soon as a location decision is made with respect to any of the subset elements. This phenomenon is known sometimes as circularity, simultaneity or externality. It means in practice that for instance the existence of one economic agent at a spatial point may prevent another agent from locating near this spatial point. Alternatively, nearness to a particular agent may be a prerequisite for some other agent to exist. It has been shown in models such as that by Clarkson and Simon (4) that using simulation techniques, one can specify the interdependence between the locational characteristics of any spatial point and the locational decisions of a set of activities.

In this paper, we shall abstract from the general equilibrium properties of the type of a highly disaggregated model such as that described above. We recognise the conceptual problems underlying the delineation of regions. On a more operational level, we shall assert that a region may be delineated on the basis of homogeneity and functionality or on the basis of uniformity of intensity with which a government plans to effect a set of spatial points. In the latter case, we say that the region has been delineated by political actors. This forms the basis for our consideration in this paper of the pre 1971 administrative regions of Buganda, Western, Eastern and Northen Provinces as our units of spatial analysis.[1] For purposes of data analysis, Buganda region consists of the old administrative districts of Masaka, East Mengo, West Mengo and Mubende. Western region consists of the old districts

1. Since the Amiri regime came into power, administrative Units have changed but there hardly is any data recorded on the basis of the new units.

of Ankole, Toro, Kigezi and Bunyoro. Eastern region consists of the old administrative districts of Busoga, Bugisu, Bukedi, Sebei and Teso. Northern region comprises of the old administrative districts of Acholi, Lango, Karamoja, West Nile and Madi. These regions are shown in fig. 1.

Having delineated four regions to coincide with administrative and data recording units in Uganda and having tabulated some of our basic data (table 1), we shall develop an intergrated Von Thunen - supply response partial location model. With this model, we shall explain the change over time in the spatial distribution of cotton across the four regions in terms of regional differentials in the monetary competitiveness of traditional subsistence crops; these regional differentials being a result of the regional inequalities in the distribution of rural and urban population and the accessibility of population centers to the food growing cotton farmer. Furthermore, we shall explain the regional differentials in the loss of competitiveness of cotton (vis a vis food crops) by reference to the price policy in the cotton industry and how this compares with the price policy in the food crop industry.

A Von Thunen - Supply Response Analysis.

Figure 2 shows the distribution of the major urban centers in Uganda. A joint inspection of figs. 2 and 1 clearly shows that by far the largest urban centers are located in or arround Buganda region. Furthermore, there is more non - land owning migrant rural population in Buganda than in any other region (7). The urban centres and the non land owning population constitute market nuclei of the marketed food crop output of the rural area in each region and sometimes across regions.

In terms of Fig. 2 and in terms of Von Thunen location theory, a system of Thunen concentric rings will develop around the population centres. Crops with a lower yield per acre and a lower price in the market will be cultivated farther away from the centres .. In the absence of modern transportation facilities, and in the case of isolated settlements, these rings would be fairly well defined. In general, we can say that the importance of the population nuclei shown in Fig. 2. for the agricultural economic landscape in Uganda will be more pronounced the less comprehensive and less efficient the commodity distribution network is and vice versa.

Having made the foregoing points, we then notice that in Uganda, the population nuclei are larger and more numerous in and around Buganda. Kampala with a population of 330,700 is certainly the chief nucleus. The Eastern region clearly ranks second in the size and frequency of population centres.

Jinja - Bugembe is the main nucleus although we have to mention that its catchment area stretches across the Nile into East Mengo in Buganda region. Given that road transportation is the most common means of modern transportation, a look at any communications map of Uganda shows that the network is much more comprehensive in central Uganda than it is in any other region. The two factors (frequency of settlements and efficiency of transport) combine to produce four possible outcomes with respect to the formation of various modifications on Thunen rings on the Ugandan agricultural economic landscape. These 4 possible outcomes are shown in chart 1

CHART 1

	several Settlements	Few Scattered Settlements
Efficient Transport Between Settlements and Hinterland	(1) Thunen rings of higher return crops are wider and tend to merge. Low return crops pushed to region's periphery	(2) Thunen rings more well defined. Low return crops nearer population centres than is the case in (1) Low return rings may merge
Inefficient Transport.	(3) Thunen rings more well defined. Low return crops nearer population centres than in case (1) Low return rings may merge	(4) Thunen rings most well defined according to differential rates of profitability

As will be observed on chart 1, case (2) gives a similar outcome as case (3). Case (1) shows a plausible description of the situation in Buganda and the southern part of eastern region. Some combination of cases (2) (or 3) and (4) offer a plausible description of many parts of North and Western Uganda.

The Changing Relative Rate of Profitability of Cotton

Since the late 1950's and more so since 1971, due partly to commodity marketing and pricing policy and due more recently to the skyrocketing food prices and the general decline in the efficiency of the transportation network, marketed food commodities do yield a higher rate of return to farmers than cotton, a traditional cash crop. The lint marketing board determines a producer price for seed cotton and determines the ginning and baling margins at a sufficiently low level such as to guard against deficits that are apt to result from the fact that its operating costs are constatly rising out of proportion with its scale of operations. Table 2 shows the money breakdown for every pound of lint cotton exported by the lint marketing board.

In this table, the absolute magnitude of each of the six factors determining the level of producer prices is presented. Furthermore, the percentage of the total export price is shown for each factor. It will be noticed in row 1 of the table that producer prices have at their highest been 23% of the c.i.f. export price. The ginning and baling allowances were a lower percentage of c.i.f. export price than the producer prices were up to 1958, but remained higher from then up to 1965. Then the lint Marketing Board substatially reduced this allowance to make good its deficits. Export tax as a percentage of export price was highest at 20% in 1951, and until 1953 was a bigger share of export price than producer price. The relative percentages of the two remained about the same up to 1957, when export prices started falling. Thereafter, the percentage of export taxes has been substantially lower. Until 1952, the share of Marketing Board net surplus (deficit) was more than twice as large as the share of producer price in the export price. Thereafter, its share was lower but positive up to 1958. It has since been negative and somewhat increasing in absolute value except for the year 1960. By far the biggest share of the export price is the item listed as "Administative, Freight, Insurance, Marketing and Miscellanous Expenditure". Unfortunately, because of the data deficiencies, it was not possible to break down this item completely into its component parts, but as can be seen, its share of the export price is unbelievably high. Almost each year it is more than twice the share of producer prices.

Pricing policy is not the only factor explaining the declining relative rate of profitability of cotton but it is very important especially in the light of the fact that there are no comparable producer price controls on potentially competing food crops. The latter have therefore interchanged with cotton in the rate of return. In the light of less inefficient transport in

Table 2. A Comparison of Producer Prices, Ginning and Baling Allowance, Marketing Costs, Export Duty and Marketing Board Surplus (Deficit) with Export Price

Cents per Pound

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
1. Producer Prices per lb. of seed cotton	33	45	33	50	51	61	55	56	58	47	48	55	57	57	51	56	40	45
2. % of Export Price	12.2	10.8	12.4	16.7	16.8	19.8	18.5	18.4	22.3	18.6	17.6	21.3	n.a	23.9	20.2	22.2	17.9	20.1
Ginning and Baling for Export	23	25	33	57	46	42	50	53	53	57	53	57	58	58	74	50	36	40
% of Export Price	8.5	6.0	8.2	19.0	15.1	13.6	16.8	17.4	20.4	20.2	19.5	22.1	n.a	24.4	29.4	19.8	16.1	17.9
3. Local Gov't Bonus and Railage Charges	16	18	22	8	12	10	14	14	16	16	16	18	8	18	22	30	30	22
% of Export Price	5.9	4.3	5.5	2.7	3.9	3.2	4.7	4.6	6.2	6.2	5.9	7.0	n.a	7.6	8.7	11.9	13.5	8.8
4. Administrative, Freight, Insurance, Marketing and Miscellaneous Expenditure	97	91	107	135	125	129	125	128	140	151	94	110	122	99	143	109	147	100
% of Export Price	35.9	21.9	26.6	45.0	41.1	41.9	42.0	53.9	53.9	58.6	34.6	42.6	n.a	41.5	56.7	43.3	65.9	44.6
5. Export Tax.....	42	86	80	44	49	49	46	57	30	26	35	33	20	49	37	332	24	22
% of Export Price	15.6	20.7	19.9	14.7	16.1	15.9	15.4	16.7	11.5	10.1	12.9	12.8	n.a	20.6	12.3	13.7	10.8	9.8
6. Marketing Board NetSurplus/Deficit	.59	.151	.111	.28	.21	.17	.8	.3	-37	-34	-16	-15	-49	-43	-9	-25	-54	-15
% of Export Price.....	21.9	36.3	27.5	2.8	6.9	5.5	2.7	1.0	14.2	13.2	5.9	5.8	n.a	18.1	3.6	9.9	24.2	6.7
7. Export Price of Lint Cotton, c.i.f. Liverpool quoted by ICAC	270	416	403	300	304	308	298	305	260	258	272	258	n.a.	238	252	252	223	224

Source: Uganda Lint Marketing Board, Annual Report.

Buganda and South Eastern Uganda and in terms of the urban market for food crops, modified Thunen-rings that include cotton have been pushed to the periphery of this region; hence a decline in acreage and output in this area.

The Thunen partial location model discussed so far is in essence a model of farmer response to changing relative profitablity of feasible alternative crops. The feasible alternatives to the cotton farmer differ from region to region. We shall now specify what they are, then construct and estimate regional farmer response models whose parameters will show that cotton production in Uganda will tend to relocate itself out of the central region (Buganda).

Summary of Production Alternatives Available to Cotton Farmers in Uganda's Four Regions

A geographical study of the current cotton producing area, reveals that mixed beans, cassava, groundnut, maize, sorghum millet, finger millet, plantains and sweet potatoes are the major cropping alternatives to cotton farmers in Eastern Uganda. In the Western region, this list includes field peas and tobacco in addition. In Northern Uganda, the list includes pigeon peas, tobacco, and simsim in addition, but does not include plantains. In Buganda, the most important cropping alternatives are mixed beans, soya beans, cassava, robusta coffee, groundnuts, maize, sorghum millet, finger millet, plantains and sweet potatoes. These must in one way or another be taken into account as significant food and cash earning alternatives to cotton production.

It is the major contention of this paper that where as prior to 1960 the secular decline of cotton acreage in Buganda could be credibly explained in terms of the increased acreage in coffee, in post independence Uganda, this must be more largely explained in terms of the increasing marketability of and higher returns on the traditional subsistence crops listed in the foregoing paragraph. It is this contention which the Thunen analysis shaded light on that we shall now prove more rigorously using statistical techniques.

Competing Food Crops as major Factors in the Locational Characteristics of Cotton: Regression Analysis.

We shall start by defining variables X_{it} is as defined in table 1; i = 1, 2, --, 4 where in this and subsequent variables, subscripts 1,2,3 and 4 refer to Eastern, Western, Northern and Buganda regions respectively and t is a time subscript . Y_{1t} is the sum of the acreage devoted to the

to the production in each region of the food crops listed in the previous section. PC_t is the producer price of cotton. The dependent variable is $[\ X/Y\ ]_{it}$ which is a measure of the allocation of land inputs to cotton relative to food crops. Even in the absence of a comprehensive price series for the various food crops mentioned, we can still develop a model to explain variations in $[\ X/Y\ ]_{it}$. The explanantory variable will be taken to be the farmers' expected "normal" price of cotton, PC^*_t, as a proxy for expected "normal" return. PC^*_t will be last period's expected "normal" price plus some factor which is proportional to the difference between actual and expected "normal" price and the proportionally factor is called the coefficient of expectations. As to the mathematical version of this statement, specification of the lag structure and econometric conditions to be satisfied, the reader is referred to the more detailed treatment in (2). The relationship between $[\ X/Y\ ]_{it}$ and PC_t suggest regressions of the form.

$$(1)\quad [\ X/Y\ ]_{it} = a_i + b_i PC_{t-1} + c_i\ [X/Y\ ]_{it-1} + V_{it}.$$

where a_i, b_i and c_i are parameters to be estimated; V_{it} are observed deviations from the regression lines in the $[X/Y\ ]_{it}$ direction. Equation (1) will be estimated for each of the regions using ordinary least squares technique. The log version of the variables will be adopted for ease of calculation of relative acreage responses to changes in PC_t.

The Data

The period covered by the data is 1945 - 1966; i.e., t = 1945, ---1966. X_{it} and PC_t are shown in table 1; Y_{it} are shown in table 3. In the case of Y_{2t}, only the food crop acreage in Toro and Bunyoro districts is considered as these are the only significant cotton producing areas in the west. The variable DU is a dummy variable that takes on the value 0 or 1 as shown in table 3 and is considered an explanantory variable in determining $[X/Y]_{it}$ because it shows the 1963 transfer of the cotton growing countries of Buyaga and Bugangaizi from Buganda to western region.

Statistical Results

The results of the estimations are shown in table 4. Before we can use these results, we have to first check them for serial correlation to make sure the estimates are not biased. We do this by applying the Durbin Watson test.

TABLE 3

FOOD CROP ACREAGE IN UGANDA'S FOUR REGIONS
1945-1966

Year (t)	Y_1	Y_2	Y_3	Y_4	DU
1945	1676000	204000	779000	855000	0
1946	1587000	247000	837000	1066000	0
1947	1487000	240000	885000	955000	0
1948	1597000	233000	944000	1016000	0
1949	1636000	244000	1081000	1090000	0
1950	1666000	248000	1137000	981000	0
1951	1717000	258000	1139000	999000	0
1952	1593000	268000	1186000	1063000	0
1953	1932000	281000	1260000	1498000	0
1954	2207000	269000	1256000	1381000	0
1955	2048 000	256000	1198000	1288000	0
1956	2061000	245000	1114000	1188000	0
1957	1957000	246000	1147000	1055000	0
1958	2171000	288000	1142000	1027000	0
1959	2379000	311000	1275000	1171000	0
1960	2040000	238000	1225000	1184000	0
1961	2294000	272000	1545000	1167000	0
1962	2353000	248000	1442000	1125000	0
1963	2306000	341000	1581000	1172000	1
1964	2688000	438000	1893000	1412000	1
1965	3041000	360000	1727000	1510000	1
1966	3106000	410000	1932000	1486000	1

Source: See Table 1.

TABLE 4.

REGRESSION COEFFICIENTS FOR REGIONAL RELATIVE ACREAGE FUNCTIONS

FOR UGANDA COTTON AND FOOD CROPS, 1945-1966[1]

Region	Constant	Price od cotton Lagged lyr.	Acreage of cotton Divided by Acreage of Food Crops and All Lagged 1 yr.	DU	R^2	D-W[2]
Eastern	3.654282	-.0291785	.0701527			
	(.795924)	(.0756673)	(209342)		.0119	2.1246
	4.591245*	-.385616*	.335111*			
Western	.364696	.128095	.702951	.022257	.6609	2.0301
	(.719631)	(.200072)	(.174446)	(.160815)		
	.506782*	.640247*	4.029622*	.138402*		
North	3.65681	-.194502	.152881		.1229	2.2229
	(1.063144)	(.163591)	(.192702)			
	3.439649*	-1.188949*	.793356*			
Buganda	.221025	.385926	.373092	.456806	.6996	1.6783
	(1.084949)	(237877)	(.179274)	(.125288)		
	.203719*	1.622376*	2.081130*	-3.646043*		

1. The figures in parentheses are the standard errors of the estimates.
2. D.W. = Durbin Watson Statistic

* T- Statistic.

Let the null hypothesis be that the disturbances are not correlated and the alternative hypothesis be that they positively autocorrelated. The null hypothesis is rejected in favor of the alternative hypothesis when the Durbin-Watson statistic of the tregression takes a sufficiently small value. For each of the regions, there are 4 sample statistics to be estimated and with 21 observations, we shall reject the same null hypothesis in favor of the alternative hypothesis if D-W<1.03. We shall accept the null hypothesis and reject the alternativehypothesis if D-W>1.67. The test will be inconclusive if 1.03<D-W<1.67. Looking at table 4 in all the regressions, the Durbin-Watson statistic is greater then 1.67 which makes us accept the null hypothesis. There is no evidence, therefore, that the estimates are biased.

These results show very interesting regional differences in the response of crop acreage mix to changes in cotton prices. The food crop factor seems to be negligible at any reasonable level of statistical significance in Eastern and Northern regions. In fact, looking at the parameters and R^2, the model hardly explains any changes in crop acreage mix in these two regions. In the case of western region, it explains 66% of the variations but as column 2 of table 1 will show, this is not a major cotton region. The results are most interesting for Buganda. The price coefficient is significantly different from zero at the 0.10 level of significance while the lagged relative acreage coefficient is significantly different from zero even at the 0.025 level. Looking at R^2, the model explains about 70% of the variations in crop acreage mix.

the "Sensitivity" of Crop Acreage Mix to Changes in Cotton Producer Prices

We can now develop the concept of sensitivity of acreage shares. Sensitivity of acreage shares is the responsiveness of crop acreage mix to variations in cotton producer prices. If we define the sensitivity index as the quotient of the resultant proportional change in $(X/Y)_{it}$ and the causal proportional change in PC_{t-1} then since all variables were transformed to logs, the price coefficients estimated do measure this "sensitivity". Since this sensitivity is fairly high in Buganda (0.385926 in the short run and 0.615 in the long run)[2] this is a sufficient condition to show that over the long run, cotton production will decline fastest in Buganda with the relative loss of competitiveness of this crop in bringing monetary returns to the multi-product "peasant" farmer. This will be increasingly reinforced by shortage of farming land.

2. For technique of calculating long run sensitivity of crop acreage shares, see (2).

CONCLUSION

In this paper we have tried to apply certain tools of supply and location theory to explain how the response of cotton farmers to differentials in the rates of return of alternative crops has led to an agricultural landscape that is tending to push cotton production out of Central Uganda. We know that the profitability of growing any crop is a function of price, costs and the physical productivity per acre of the land. In the case of Ugandan cotton, physical productivity per acre has been rising as the appendix points out. Yet this has not been directly converted to the advantage of the farmer as not only have costs tended to rise but more so because of pricing policy. The net effect has been to reduce the profitability of growing cotton in relation to marketable food crops. The pattern of cotton distribution is therefore changing according to the botanic feasibility of growing alternative food crops and according to accesibility of the mainly urban markets for these crops. This is a dynamic situation that cannot be reversed by any non economic policies either in the form of "Double Production Campaigns" or in the name of the "economic war". If the agricultural landscape is to be changed and output increased simultaneously, appropriate regional differentials in producer prices must be instituted according to spatial variations in the sensitivity of crop acreage shares to changes in producer prices.

APPENDIX

Seed Selection and The History of Commercial Cotton Growing in Uganda

There is little evidence that the cotton crop is indigenous to Uganda. The history of commercial cotton growing in Uganda is well documented and all the strains grown in the country are cross-breeds of previously imported strains. Economic cultivation of cotton dates as far back as the beginning of thi· century and was initially concentrated in the Central/Southern part of the country in the area known as Buganda. Consequently, the major research work and the location of the first research facilities was concentrated in this area.

Since 1900, a programme of seed selection to over-come certain plant deficiencies and to meet ginning and spinning specifications has been the prime concern of the research stations at Serere in Teso (Eastern Region) and Namulonge (Buganda region). During the period 1903 to 1910, a number of varieties of cotton were introduced into Uganda and experience was gathered on the value of each imported strain growing ·under local conditions. This period marks the first attempt to found extensive cotton industry in Uganda. In 1907, a cotton conference was held and it decided that in future, importations of strains should be limited to American Upland varieties. Nevertheless, some attention was also paid to Egyptian varieties already in the country. These Egyptian varieties were later finally abandoned as useless under the Ugandan enviromental conditions.

During the period 1911 to 1920, the industry developed on the basis of two American varieties, "Allen" and "Sunflower". In 1911, the first cotton experimental station for the increase of new varieties was opened at Kadinguru in Teso District and in 1912, selection work was carried out on "Allen" and "Sunflower" to get strains suited to local conditions. In 1915, another variety, "Nysaland Upland" was introduced in the country.

During the period 1920 to 1970, the major impetus to research was the urge to reduce the seriousness to the crop of bacterial blight known as "blackarm" and also as "xanthomonas malvacearum" The strains already in the country showed different resistance to blackarm but the most resistant of them all was the Upland variety "gossypium hirsutum". There was speculation that immunity to blight existed in unselected upland storks in Northern Nigeria. Subsequently, gene-run seed was imported and selected rigorously for resistance to xanthomonas malvacearum.

In the first generation, a few immune plants appeared and from their seeds, a stork which became known as "Albar" was developed. As had been speculated, the Albar stork showed unmistakable signs of introgression from punctatum. From the genetic diversity thus generated, a number of high yielding, highly resistant storks with a range of quality characteristics were selected either as local selections or as Albar crosses.

Development of the B.P. 52, S. 47, B.P.A. and SATU Varieties

Towards the beginning of the Second World War, a major project originated with the breeding and seed supply of "Sea-island" cotton from the West Indies. This research effort led to the development of the B.P.52 and S.47 varieties. The B.P. 52 was grown beginning 1939/40 and the S. 47 beginning 1947/48. The B.P. 52 produced a longer and stronger fibre than the S.47. Consequently, the B.P. 52 was in greater demand. These two varieties formed the basis of the industry until the early 1960's.

In 1955 the N.C. 54 variety was developed out of the B.P.52. It turned out to have higher lint outturn ratio, but the length of the staple was slightly reduced. Selection work to improve the S. 47 resulted in the varieties D.E. 715/6M in 1955 and B.C. 177 in 1960. However, these were all called S. 47 because of their similarity to the original S. 47.

The most recent contribution of the seed selection programme has been the development of the BPA and SATU varieties that have now almost completely supplanted the S. 47 and B.P.52 varieities. Both have been developed from Albar stocks and are much more resistant to bacterial blight than B.P.52 and S.47. SATU was released in 1964 and grows through Northern Uganda. BPA was released in 1966 and had spread throughout theSouthern growing areas by the 1970/71 season. The physical distribution of the varieties currently grown is shown in fig. 1. With the introduction of SATU (Serere Albar Type Uganda) the mean yields in the North and Eastern regions rose from 295 lbs. per acre in 1963 to 343 lbs. in 1964. From district variety trials in the B.P. cotton area, BPA has over a period of seven seasons given increases of lint of 22% over B.P.52. In the trials in the Southern area over seven seasons, SATU has raised the average yield by 17% over the S47. The yarn strength is comparable to that of the predecessors but the staples are longer.

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