Virginia Agricultural Experiment Station **Bulletin 83-2**
Virginia Polytechnic Institute and State University

Production, Consumption and Storage of Virginia Corn and Soybeans

David E. Kenyon and Karen P. Mundy

James R. Nichols, Dean and Director
College of Agriculture and Life Sciences
Virginia Agricultural Experiment Station
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

The Virginia Agricultural and Mechanical College came into being in 1872 upon acceptance by the Commonwealth of the provisions of the Morrill Act of 1862 "to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life." Research and investigations were first authorized at Virginia's land-grant college when the Virginia Agricultural Experiment Station was established by the Virginia General Assembly in 1886.

The Virginia Agricultural Experiment Station received its first allotment upon passage of the Hatch Act by the United States Congress in 1887. Other related Acts followed, and all were consolidated in 1955 under the Amended Hatch Act which states "It shall be the object and duty of the State agricultural experiment stations . . . to conduct original and other researches, investigations and experiments bearing directly on and contributing to the establishment and maintenance of a permanent and effective agricultural industry of the United States, including the researches basic to the problems of agriculture and its broadest aspects and such investigations as have for their purpose the development and improvement of the rural home and rural life and the maximum contributions by agriculture to the welfare of the consumer . . . ."

In 1962, Congress passed the McIntire-Stennis Cooperative Forestry Research Act to encourage and assist the states in carrying on a program of forestry research, including reforestation, land management, watershed management, rangeland management, wildlife habitat improvement, outdoor recreation, harvesting and marketing of forest products, and "such other studies as may be necessary to obtain the fullest and most effective use of forest resources."

In 1966, the Virginia General Assembly "established within the Virginia Polytechnic Institute a division to be known as the Research Division . . . which shall encompass the now existing Virginia Agricultural Experiment Station . . . ."

PRODUCTION, CONSUMPTION, AND STORAGE OF VIRGINIA CORN AND SOYBEANS

David E. Kenyon and Karen P. Mundy

Virginia Polytechnic Institute and State University
Department of Agricultural Economics
Blacksburg, Virginia

Virginia Agricultural Experiment Station
Bulletin 83-2 April 1983

ABSTRACT

Virginia does not produce sufficient corn and soybeans to meet feed demand by livestock and poultry within the state. The objectives of this study were to 1) determine the magnitude of the deficit, 2) determine if storage was aggravating the problem, and 3) determine why Virginia does not produce enough corn and soybeans to meet feed demand.

Typical rations were used in conjunction with estimates of livestock and poultry numbers to determine total consumption. Corn and soybean consumption have increased 37 and 58 percent, respectively. Along with these increases in the consumption of corn and soybeans, production has also increased. The result is that the deficit of corn, relative to production has decreased from 11 to 4.6 million bushels, whereas for soybeans the deficit has increased from 4 to 5.2 million bushels.

On a state-wide basis storage was not, on the average, a restrictive factor. When storage was considered relative to production and consumption on a regional basis the picture changed. The impact of insufficient storage is to increase the magnitude of the deficit since the corn and soybeans cannot be stored for later consumption.

Once the relationships among production, consumption, and stoage were determined, the question of why more corn and soybeans were not produced was considered. The least cost source of corn and soybeans for deficit regions shows that shipping corn within the state is more expensive in most cases than importing from the Midwest. Thus, increased corn production is not likely to reduce the corn feed deficit unless it can be produced in the deficit regions. Soybean meal is priced FOB Decatur plus a basis for Virginia plus transportation costs based on shipment from Decatur. Hence, soybean meal consumed in Virginia can be purchased at lower delivered prices from the midwest than Virginia processors. Consequently, increasing the production of soybeans in Virginia for the purpose of feeding livestock and poultry is not likely to occur.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter I

INTRODUCTION

Virginia is a deficit feed-grain state. The livestock and poultry feeding sectors are concerned that increasing transportation costs on imported grain may put them at a competitive disadvantage compared to other regions of the United States. Grain and soybean producers are concerned that storage and distribution problems within Virginia may be reducing the average price they receive for corn and soybeans. Both groups are hindered by a lack of information about how large the deficit is by commodity, where and when it occurs, and whether or not it is increasing or decreasing over time. This study was conducted to determine the actual nature of the feed deficit situation in Virginia. This information should help individual decision-makers and organizations in the grain-livestock complex in planning for the future and analyzing policies that offset their industry's problems.

The general objective of this study is to determine the current production, consumption, and storage situation for corn and soybeans in Virginia. Specific objectives are:

1. To determine the magnitude of the deficit in corn and soybeans at the state level;
2. To determine the relationship between production, consumption and available storage capacity by region within the state;
3. To determine why Virginia does not produce sufficient corn and soybeans to meet the demand by livestock and poultry.

Procedures

This analysis covers the years 1964 to 1979 with emphasis on comparing the 1965/66-1968/69 period and the 1975/76-1978/79 period. These two periods are referred to as the first or earlier period versus the second or later period. Using an average of four years for each period allowed comparisons to be made without destroying the effect of seasonal patterns but reducing the effects of short crops or cyclical patterns in livestock and poultry.

Typical livestock and poultry rations were developed and used in conjunction with livestock and poultry numbers

to determine corn and soybean meal consumption on a monthly basis. Monthly consumption was compared to annual production and storage to determine when Virginia became deficit. The adequacy of storage state-wide and regionally was determined by comparing total storage capacity, rate of harvest, and rate of consumption.

To determine why Virginia does not produce enough corn and soybeans to meet its consumption needs, the state was divided into regions. Within each region it was determined if a surplus or a deficit existed in the relationship between consumption and production and storage. Once surplus and deficit regions were identified, a linear programming model was used to determine the least cost method of providing corn and soybean meal to the deficit regions.

Originally barley was to be included in the study. Poultry and cattle are fed some barley when it is cheap relative to corn. Horses being conditioned are fed barley. Barley consumption by other livestock is negligible. In all cases the quantity fed is impossible to determine; therefore, barley was dropped from the study realizing that the result would be an overestimate of the use of corn and soybeans.

Chapter II

FEED CONSUMPTION

United States Department of Agriculture (USDA) reports livestock and poultry numbers at various intervals during the year. Since one objective of this study is to determine when during the crop year Virginia becomes deficit, it was necessary to have estimates of animal numbers on at least a quarterly basis. Estimates could be obtained on a monthly basis for broilers, layers, dairy cows, and turkeys. Hog numbers are available for Virginia semi-annually. Annual estimates of dairy heifer replacements, beef cattle, cattle on feed, and sheep are available as of January 1. Horse numbers are available during agricultural census years. Because of these inconsistencies in data availability, procedures to estimate all livestock and poultry numbers on a monthly basis were devised.

Rations used to calculate feed consumption and rate of gain are based on information from extension personnel, USDA

estimates, and National Research Coucil (NRC) feed recommendations. There have been changes in feeding levels over the period considered. These changes are reflected by changes in conversion factors, feed intake, and length of time on feed. Not considered in these changes is the effect that changing prices have on feed levels and alternative rations. The rations used are typical or normal rations. Individual producer or regional variations will occur.

Two general assumptions were made that are relevant to all livestock and poultry rations. It was assumed that corn contains 9 percent protein and soybean meal 44 percent protein. Secondly, it was assumed that each bushel of corn weighs 56 pounds and that each bushel of soybeans produces 47.3 pounds of 44 percent soybean meal. Throughout the study, soybean meal consumption was converted to soybean equivalents in bushels using these assumptions.

The estimated monthly livestock and poultry numbers along with the typical ration were used to determine monthly corn and soybean consumption by broilers, layers, turkeys, hogs, cattle on feed, all other beef, dairy, sheep, and horses. Many assumptions were necessary to determine numbers fed and feed consumption for each category of poultry and livestock. The procedures used to determine hog feed consumption are given in detail to demonstrate the

methodology used. Similar procedures were used for all other livestock and poultry categories. The details of these procedures are available in the thesis by Mundy.

Hogs

USDA publishes Virginia hog inventories only semi-annually, therefore, a method to calculate the number of hogs fed monthly in Virginia was developed.

USDA pig crop and market hog inventory numbers indicate that it requires 6.6 months to produce, from farrow-to-finish, a market hog weighing 235 pounds, the average liveweight of market hogs in Virginia. When comparing Virginia pig crop numbers for 6.6 months to the appropriate market hog numbers, it became evident that the difference between the two was more than rounding errors. It was determined that this difference was inshipments of feeder pigs. The number of feeder pigs imported was determined by comparing 6.6 months of pig crop to market hog inventories. The difference between inventory numbers and pig crop were assumed to be imports. Imported feeder pigs were assumed to weigh 50 pounds and require 4.5 months of feeding to reach an average market weight of 235 pounds. Inshipments were assumed to arrive in equal amounts on the first of each month.

The quantity of feed consumed was calculated based on the previous and following assumptions. It was assumed that breeding stock numbers remain constant over a 6 month period, that each boar services 15.75 sows (Van Arsdall), and that sows farrow twice a year on the first of the month. Average weaning age was assumed to be 7.1 weeks (Van Arsdall). During lactation sows are fed 12 pounds of feed per day. Otherwise, they receive 4 pounds of feed per day; boars receive 5 pounds of feed per day.

Feeding rates at various weights were based on NRC recommendations. Feed efficiency for market hogs has changed over time but the length of time required on feed has not. In an attempt to adjust for these changes, the 1973 NRC recommendations were used from 1964 to 1976 and the 1978 NRC recommendations from 1977 to 1979. Feed requirements for breeding stock have remained unchanged.[1] It was found, using 1973 NRC recommendations, that 13.8 bushels of corn and 2.7 bushels of soybeans were required to produce a market hog from farrow to finish. With improved technology and feed efficiency the current requirements to raise a market hog from farrow to a finish weight of 235 pounds are 11.7 bushels of corn and 2.5 bushels of soybeans.

---

[1]Dr. E. T. Kornegay, Swine Nutrition Specialist, VPI & SU.

Breeding stock requires 4.9 bushels of corn per month and 1.2 bushels of soybeans per month to raise 2 litters of pigs.

Hog numbers in Virginia have increased 30 percent from the earlier period to the later period. Inshipments which were as low as 0.3 percent of the pig crop in December, 1965 rose as high as 98 percent of the pig crop in December, 1979. Generally, inshipments are greatest from June through November (Table 1).

Table 2 shows that definite seasonal patterns occur in the quantity of corn consumed by hogs. The increase in quantity consumed reflects increases in the number of hogs fed since there has been an increase in feed efficiency resulting in a decrease in per head consumption. In both periods the lowest corn consumption occurred in July, with an increase in consumption of 12.4 percent from the earlier to the later period. Peak consumption occurred in November in the earlier period and in January in the later period. Peak consumption increased 16.4 percent from one period to the next.

Table 3 shows that soybean meal consumption follows a similar pattern to that of corn with least consumption occurring in July and greatest in November. Similar

Table 1. Semi-Annual Market Hog Inventory (in 1000 head)

Year	Month	Market Hogs	Pig Crop	Total Inshipments[a]	Inshipments As % of Pig Crop
1965	Dec.[b]	403	402.02	1.31	0.3
1965	June	401	389.24	15.68	4.0
1966	Dec.	463	389.76	97.65	25.1
1966	June	405	398.44	8.75	2.2
1967	Dec.	514	447.54	88.61	19.8
1967	June	464	431.70	43.07	10.0
1968	Dec.	530	454.50	100.67	22.1
1968	June	477	419.12	77.17	18.4
1969	Dec.	516	464.00	69.33	14.9
1969	June	501	447.50	71.33	15.9
1970	Dec.	627	463.46	218.05	47.0
1970	June	540	497.30	56.93	11.4
1971	Dec.	595	500.28	126.29	25.2
1971	June	561	503.18	90.43	18.0
1972	Dec.	537	455.20	109.07	24.0
1972	June	509	441.00	90.67	20.6
1973	Dec.	527	417.00	146.67	35.2
1973	June	498	392.40	140.80	35.9
1974	Dec.	506	400.88	140.16	35.0
1974	June	493	419.84	97.55	23.2
1975	Dec.	538	416.60	161.87	38.9
1975	June	456	369.58	115.23	31.2
1976	Dec.	559	511.00	64.00	12.5
1976	June	478	402.56	100.59	25.0
1977	Dec.	578	452.96	166.72	36.8
1977	June	507	411.44	127.41	31.0
1978	Dec.	583	390.36	256.85	65.8
1978	June	558	432.86	166.85	38.5
1979	Dec.	735	423.64	415.15	98.0
1979	June	632	543.20	188.40	21.8
Average Dec.		554	450	144	
Average June		496	451	93	

[a]Total inshipments are for 6 month period.
[b]December preceding year.

Table 2. Monthly Corn Consumption by Hogs (in 1000 bu.)

Year	Total Hogs (1000)[a]	Month Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.[b]	Total
1965	881	1199	1188	1180	1196	1212	1224	1214	1224	1248	1304	1337	1121	14645
1966	980	1397	1343	1279	1234	1241	1260	1229	1260	1312	1391	1444	1358	15747
1967	1098	1523	1471	1414	1389	1400	1414	1369	1373	1389	1440	1481	1484	17147
1968	1139	1545	1512	1471	1447	1439	1431	1390	1383	1383	1405	1442	1515	17362
1969	1142	1531	1509	1486	1481	1484	1486	1518	1580	1667	1774	1816	1481	18815
1970	1338	1853	1757	1641	1559	1575	1619	1523	1556	1604	1659	1676	1834	19855
1971	1314	1751	1700	1646	1632	1657	1688	1573	1568	1565	1573	1567	1677	19597
1972	1182	1572	1521	1466	1456	1481	1509	1453	1464	1485	1521	1533	1550	18010
1973	1185	1599	1556	1508	1496	1507	1521	1384	1387	1392	1399	1406	1530	17686
1974	1141	1530	1504	1476	1463	1479	1501	1640	1659	1690	1741	1765	1411	18859
1975	1176	1651	1584	1503	1451	1442	1440	1376	1395	1429	1474	1546	1775	18064
1976	1175	1683	1633	1575	1552	1526	1490	1197	1225	1272	1335	1380	1626	17492
1977	1241	1501	1452	1395	1364	1363	1365	1357	1384	1431	1497	1518	1415	17042
1978	1341	1565	1520	1468	1439	1464	1502	1629	1697	1797	1916	1944	1521	19462
1979	1617	1897	1820	1716	1608	1625	1683	1751	1755	1766	1796	1831	1942	21188
Average	1196	1586	1538	1481	1451	1459	1475	1440	1460	1495	1548	1579	1549	18064
1965-1968 Averages	1024	1415	1378	1336	1316	1322	1332	1300	1310	1332	1384	1426	1369	16224
1975-1979 Averages	1310	1659	1601	1531	1482	1483	1496	1461	1491	1538	1603	1643	1655	18649

[a] Total hogs = 6.6 month pig crop + total inshipments + (Dec. breeding stock + June breedstock)/2.
[b] December preceding year.

Table 3. Monthly Soybean Consumption by Hogs (in 1000 bu.)

Year	Total Hogs (1000)[a]	Month Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.[b]	Total
1965	881	258	258	259	261	261	261	260	265	271	280	283	237	3153
1966	980	293	286	277	271	271	273	266	276	288	301	306	284	3392
1967	1098	318	312	305	301	301	300	291	295	301	309	314	309	3657
1968	1138	324	318	312	308	306	303	294	297	300	304	308	317	3692
1969	1142	324	321	318	317	317	317	327	341	357	373	377	313	4001
1970	1338	380	366	351	340	343	349	325	333	342	350	349	376	4204
1971	1314	365	359	353	352	355	358	330	330	330	330	326	346	4135
1972	1182	327	321	315	314	317	320	306	310	314	319	318	319	3797
1973	1185	332	326	320	318	320	322	289	290	291	292	292	314	3707
1974	1141	321	319	316	315	316	318	353	359	366	364	374	292	4023
1975	1176	342	330	317	309	309	310	295	304	316	325	332	372	3862
1976	1175	353	343	332	328	323	317	265	274	285	294	299	340	3652
1977	1241	322	314	305	300	299	298	298	305	313	322	324	301	3700
1978	1341	334	329	323	320	323	328	361	374	390	409	413	323	4227
1979	1617	402	390	377	362	364	372	388	391	394	402	411	413	4665
Average	1196	333	326	318	314	314	316	309	316	323	332	335	323	3864
1965-1968 Averages	1024	298	293	288	285	284	284	277	283	289	298	302	287	3473
1975-1979 Averages	1310	350	341	331	323	323	324	321	329	339	350	355	349	4041

[a] Total hogs = 6.6 month pig crop + total inshipments + (breeding stock Dec. + breeding stock June)/2.
[b] December preceding year.

procedures were followed for all other livestock and poultry categories to determine corn and soybean consumption. These analyses resulted in feed consumption estimates by livestock category on an annual and seasonal basis.

Total Corn and Soybean Consumption

Total annual corn consumption by animal category from 1965 to 1979 is given in Table 4. Average annual corn consumption increased from 41 million bushels in 1965-68 to 49.2 million in 1975-78, an increase of 20 percent. Hogs are the single largest consumers of corn taking 41 percent of the total. Broilers are next consuming 19 percent. All poultry combined consumed 37 percent of the total. Hence hogs and poultry consume 78 percent of all corn fed in Virginia. Percentage of consumption by animal group for 1965-1979 is shown in Figure 1.

There have been changes over time in the quantity of corn consumed by each group relative to the total corn consumption. From the first to the second period, corn consumption by broilers increased 8 percent and by turkeys 7 percent, while that by dairy, hogs, and layers decreased 8, 4, and 4 percent respectively. Consumption by all other livestock remained relatively constant. The overall impact

Table 4. Annual Corn Consumption by Livestock and Poultry (in 1000 bu.)

Crop Year	Broilers	Layers	Turkeys	Hogs	Beef	Dairy	Cattle on Feed	Sheep	Horses	Total
1965/66	5863.1	5153.5	3429.4	15553.9	824.2	6768.6	1071.9	235.3	1128.4	40028.3
1966/67	5963.7	5087.8	3345.2	17059.4	880.3	6508.2	1064.6	232.6	1172.0	41313.7
1967/68	6388.3	4772.9	2350.4	17436.2	926.3	6138.2	1244.8	228.6	1217.2	40702.9
1968/69	7147.0	4425.3	2213.2	18071.1	967.6	6346.5	1343.7	221.9	1264.2	42000.5
1969/70	8082.7	4225.5	2494.5	20111.3	1031.1	5863.8	1370.9	215.3	1313.0	44708.0
1970/71	8374.6	4182.1	3080.3	19790.9	1040.6	4944.9	1681.9	208.6	1363.7	44667.4
1971/72	9018.7	3938.1	3182.8	18096.3	1048.5	4821.5	1573.6	192.5	1406.0	43277.9
1972/73	8891.4	3931.8	3051.0	17934.6	1082.1	4519.5	1516.6	188.5	1443.5	42458.8
1973/74	9035.4	3569.0	3302.3	18158.0	1172.8	4773.9	1324.1	187.2	1479.7	43002.4
1974/75	9092.2	3443.3	4828.3	18550.6	1444.2	4400.4	1225.1	185.9	1495.5	44665.6
1975/76	10277.3	3594.8	5762.4	17797.8	1391.5	4645.1	1469.5	171.1	1504.7	46614.3
1976/77	11136.9	3699.0	6465.8	16741.1	1477.2	3854.7	1716.6	172.5	1514.0	46777.8
1977/78	10651.1	3972.5	7283.6	18616.0	1279.9	3230.9	1914.2	181.8	1523.0	48653.0
1978/79	12751.8	4315.9	7729.9	21421.4	1159.9	4016.1	1786.0	173.8	1440.5	54795.2
Average 1965/66 - 1968/69	8762.4	4158.0	4179.9	18238.5	1123.3	5059.5	1450.3	199.7	1376.1	44547.6
Average 1975/76 - 1978/79	6340.5	4859.9	2834.6	17030.2	899.6	6440.4	1181.3	229.6	1195.5	41011.4
Average	11204.3	3895.6	6810.4	18644.1	1327.1	3936.7	1721.6	174.8	1495.6	49210.1

of these changes is that corn consumption by poultry increased from 34 to 45 percent of the total.

For purposes of analyzing seasonal consumption patterns, all daily feed consumption rates for individual livestock and poultry were multiplied by 30 to make quantities consumed comparable across all categories. Seasonal corn consumption for the entire study and for the two four-year periods is in Table 5 and Figure 2. The most obvious difference is the increase in corn consumption over time. The two periods follow similar seasonal patterns

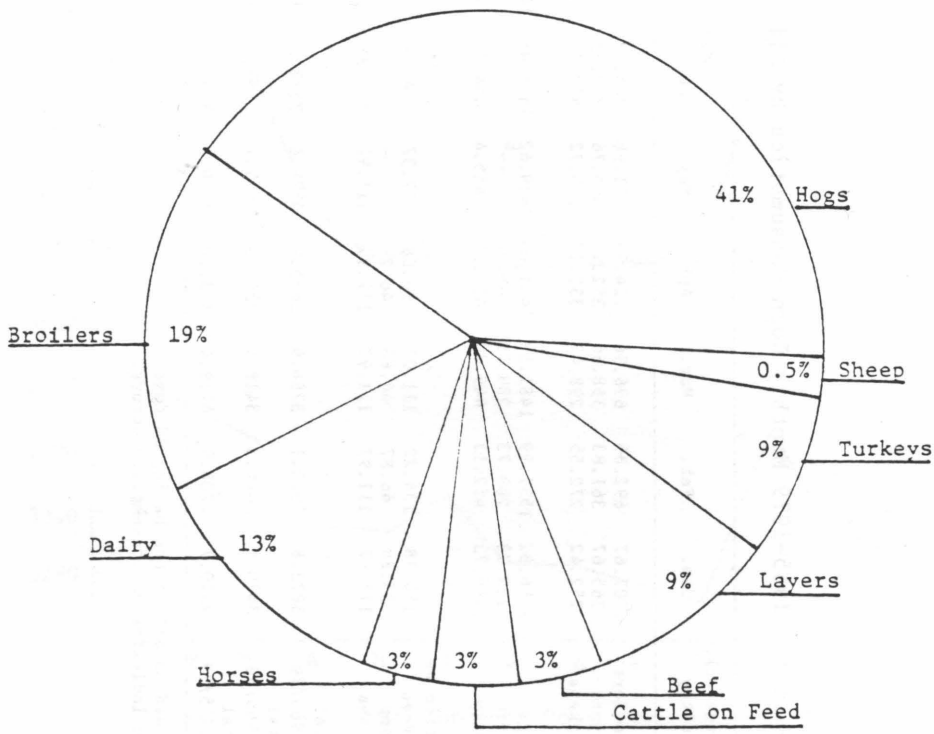

Figure 1. Percent of Total Corn Consumption By Livestock and Poultry 1965-1979

Table 5. 1965-1979 Monthly Corn Consumption By All Livestock and Poultry (in 1000 bu.)[a]

Livestock/ Poultry	Month											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Broilers	707.67	692.85	696.96	724.95	751.98	745.53	745.26	723.81	713.28	683.34	666.87	691.05
Layers	365.67	361.83	358.56	352.11	344.76	342.93	345.15	347.07	352.02	354.96	360.27	369.21
Turkeys	252.42	272.55	298.47	339.27	378.72	412.77	434.58	417.66	376.23	330.09	288.15	254.97
Hogs	1586.32	1537.99	1481.59	1451.03	1459.62	1475.48	1440.03	1460.73	1495.19	1548.24	1579.05	1549.32
Beef	209.73	209.73	209.73	48.94	--[b]	--	--	--	--	--	209.73	209.73
Dairy	449.73	452.13	449.76	457.29	455.4	454.83	416.76	414.75	414.36	423.06	422.28	416.07
Cattle on Feed	154.38	134.22	111.27	94.08	77.37	74.76	80.64	100.95	122.79	140.22	147.48	138.99
Sheep	35.86	46.87	46.68	46.26	--	--	--	--	--	--	9.62	20.16
Horses	111.97	111.97	111.97	111.97	111.97	111.97	111.97	111.97	111.97	111.97	111.97	111.97
Total 1965/79	3873.8	3820.1	3764.9	3625.9	3579.8	3618.3	3574.4	3576.9	3585.8	3591.9	3795.4	3716.5
Total 1965/69	3470.5	3440.5	3418.4	3316.6	3311.1	3357.7	3294.4	3298.6	3272.7	3259.0	3417.3	3319.2
Total 1975/79	4310.7	4208.9	4139.4	3935.0	3880.9	3939.4	3913.5	3908.0	3944.0	3977.2	4238.3	4261.9

[a]Based on all months having 30 days.
[b]-- indicates no consumption occurs.

Figure 2. Average Monthly Corn Consumption By All Livestock and Poultry 1965-1979

until April. In the earlier period feed consumption from April to May decreased approximately 5 thousand bushels compared to a decrease of approximately 54 thousand bushels in the later period. This large decrease in the quantity consumed in the later period is the result of removing more cattle from winter feeding and of a large decrease in corn consumption by cattle on feed. Consumption increases from May to June followed by a decrease in both periods. This increase is the result of increased corn consumption by hogs and turkeys in the earlier period and by hogs, turkeys, broilers, and layers in the later period. In the earlier period, beginning in August, there is a steady decrease in corn consumption which culminates with a low in October. Essentially the opposite situation occurs in the later period: consumption increases steadily from the August low until January. In the later period the increased corn consumption by layers, hogs, dairy, and cattle on feed from August through January was much greater than the decreased corn consumption by other livestock and poultry. From October to November in both periods, there is a significant increase in corn consumption due to winter feeding of sheep and beef cattle. The continued increase in consumption in December in the later period is the result of less seasonal feeding of turkeys in the 70's compared to the 60's.

Table 6 shows soybean meal consumption by all livetock and poultry. Consumption has grown rather steadily from 10.7 to 16.9 million bushels over the two time periods, an increase of 58 percent.

This increase is the result of more broilers and turkeys which are heavy consumers of soybean meal. Broilers, layers, and turkeys consume 30, 15, and 11 percent respectively. Hogs are the largest consumers of soybean meal: consuming 32 percent. Hogs and poultry combined consume 88 percent of the soybean meal fed. The percentage consumed by each animal group for 1965-1979 is shown in Figure 3.

In order to determine seasonal patterns for soybean meal consumption, the monthly consumption for all livestock and poultry categories was computed based on 30-day months. The seasonal consumption patterns of soybean meal from the mid 1960's to the mid 1970's are given in Table 7 and Figure 4. In general there is little variation in the quantity of soybean meal consumed from the peak period to the low period (less than 6 percent). The increase in summer consumption is attributable to increased turkey and broiler feeding. The increase in consumption in the late fall is the result of wintering beef cattle along with increases in hog feeding.

Table 6. Annual Soybean Consumption by Livestock and Poultry (in 1000 bu.)

Crop Year	Broilers	Layers	Turkeys	Hogs	Beef	Dairy	Cattle on Feed	Sheep	Horses	Total
1965/66	2669.8	2346.7	1206.9	3347.8	216.9	473.5	216.0	17.4	222.7	10717.6
1966/67	2715.6	2316.8	1177.3	3540.4	231.6	795.2	215.8	17.2	231.3	11241.1
1967/68	2909.0	2173.4	827.3	3702.9	243.7	855.0	250.7	16.9	240.2	11219.1
1968/69	3254.4	2015.1	778.9	3863.0	254.6	1196.7	271.8	16.4	249.5	11900.4
1969/70	3680.6	1924.1	877.9	4254.8	271.3	1090.1	277.2	15.9	259.1	12651.0
1970/71	3813.4	1904.4	1084.0	4177.3	274.8	774.9	338.7	15.4	269.1	12652.0
1971/72	4106.7	1793.3	1120.1	3815.8	275.9	707.5	319.5	14.2	277.5	12430.4
1972/73	4048.8	1741.8	1073.7	3759.7	284.7	330.0	306.5	14.0	285.0	11844.1
1973/74	4114.3	1625.2	1162.1	3860.4	308.6	599.5	268.9	13.8	292.0	12244.8
1974/75	4140.2	1567.9	1699.0	3952.4	380.0	1342.0	247.8	13.8	295.1	13638.2
1975/76	4679.9	1636.9	2027.7	3816.5	366.1	1086.9	296.0	12.7	297.0	14219.7
1976/77	5017.3	1684.4	2272.5	3646.6	388.6	1132.5	346.6	12.8	298.8	14800.0
1977/78	4750.1	1808.9	2533.2	4051.5	336.7	651.6	386.5	13.4	300.5	14932.4
1978/79	5806.7	1965.3	2720.0	4673.5	305.2	809.8	362.2	12.9	284.3	16939.8
Average	3986.2	1893.2	1468.6	3890.2	295.6	846.1	293.2	14.8	271.6	12959.3
1965/66 - 1968/69										
Average	2887.2	2213.0	997.6	3613.5	236.7	830.1	238.6	17.0	235.9	11269.5
1975/76 - 1978/79										
Average	5088.5	1773.9	2388.4	4047.0	349.2	920.2	347.8	13.0	295.2	**15223.0**

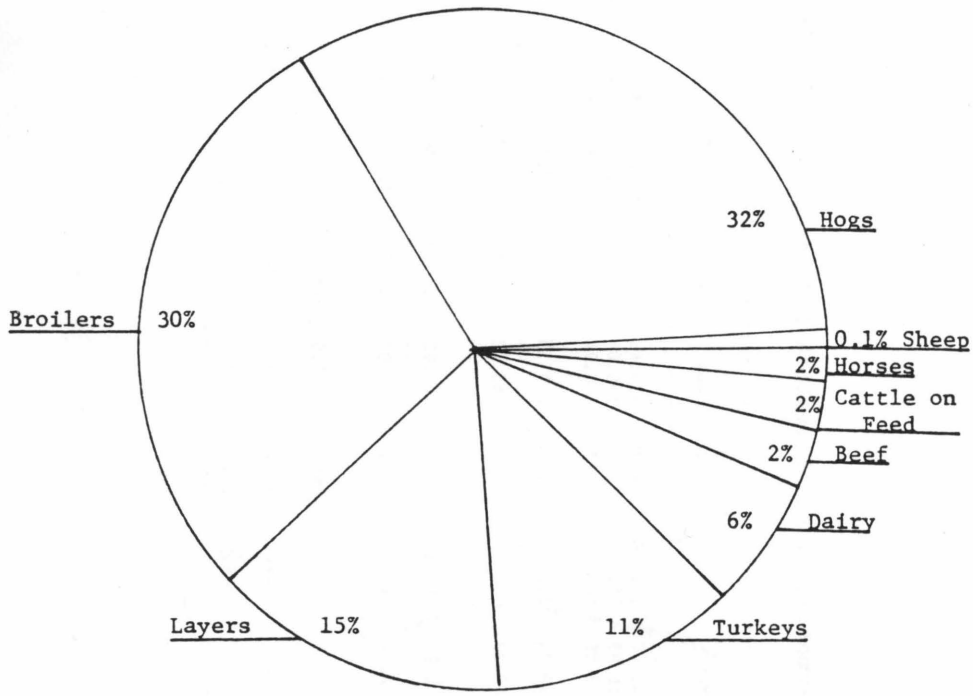

Figure 3. Percent of Total Soybean Consumption By Livestock and Poultry 1965-1979

Table 7. 1965-1979 Monthly Soybean Consumption By All Livestock And Poultry(in 1000 bu.)[a]

Livestock/ Poultry	Month											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Broilers	322.23	315.51	317.37	330.12	342.42	339.48	339.36	329.61	324.81	311.16	303.66	314.67
Layers	166.50	164.76	163.29	160.35	156.99	156.15	157.17	158.04	160.29	161.64	164.04	164.43
Turkeys	88.80	95.91	105.03	119.37	133.26	145.23	152.37	146.94	132.36	116.25	101.40	89.91
Hogs	333.03	326.05	318.72	314.35	314.92	316.43	309.86	316.15	323.81	332.25	335.04	323.79
Beef	55.18	55.18	55.18	12.88	--[b]	--	--	--	--	--	55.18	55.18
Dairy	68.43	68.82	68.55	69.66	69.39	69.33	64.20	63.03	63.87	65.37	65.31	64.41
Cattle on Feed	30.45	25.97	21.96	18.57	15.93	14.37	15.9	19.92	24.24	29.76	31.29	31.98
Sheep	2.65	3.47	3.45	3.42	--	--	--	--	--	--	0.71	1.52
Horses	22.07	22.07	22.07	22.07	22.07	22.07	22.07	22.07	22.07	22.07	22.07	22.07
Total 1965/79	1089.3	1077.5	1075.6	1050.8	1055.0	1063.1	1060.9	1055.8	1051.5	1038.5	1078.7	1068.0
Total 1965/69	907.1	900.6	907.9	901.4	909.9	922.2	919.0	919.1	905.6	885.0	909.0	886.8
Total 1975/79	1299.7	1274.3	1266.0	1228.7	1233.3	1248.5	1252.4	1242.4	1243.3	1235.6	1292.0	1295.4

[a]Based on all months having 30 days.
[b]-- indicates no consumption occurs.

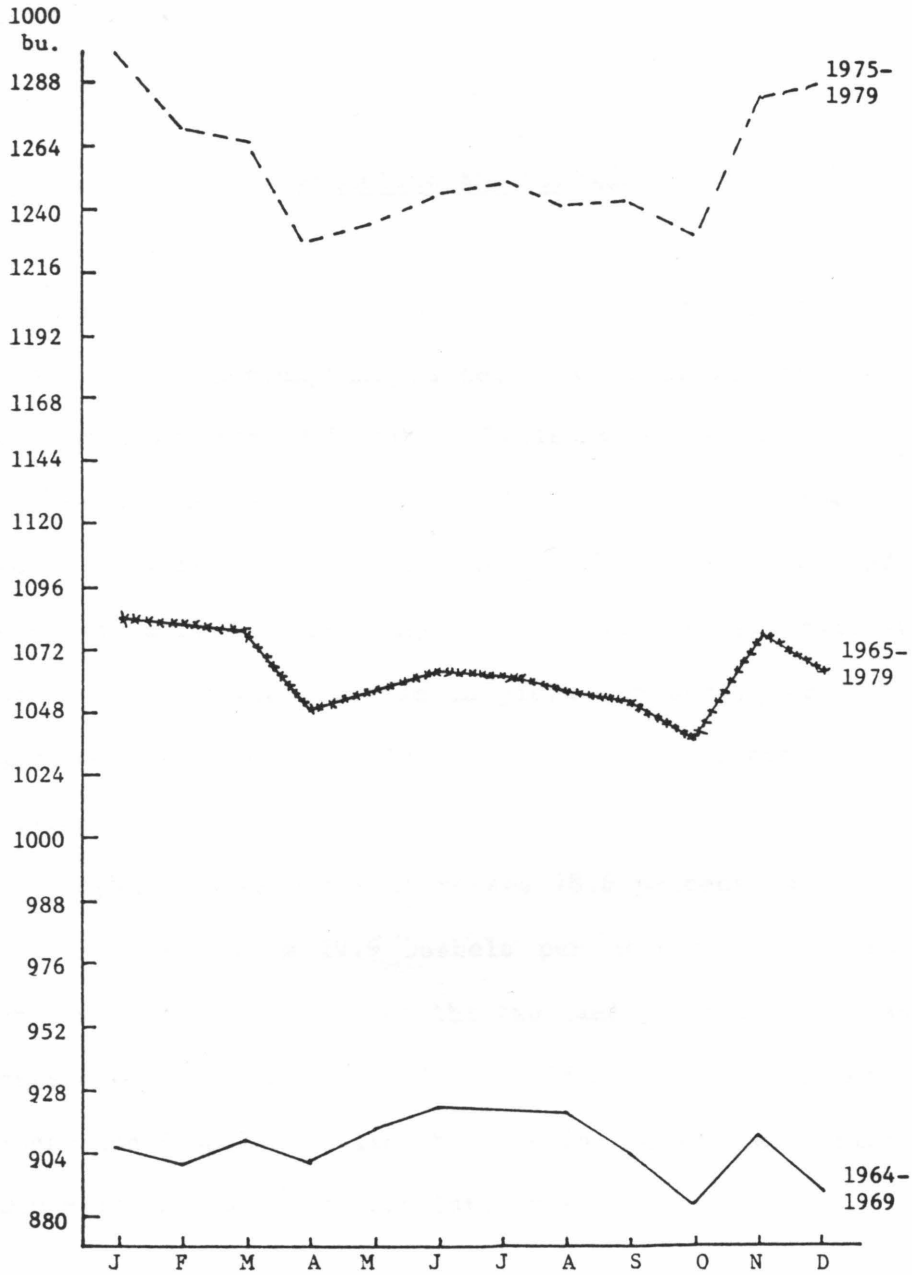

Figure 4. Average Monthly Soybean Consumption By All Livestock and Poultry 1965-1979

Chapter III

PRODUCTION AND STORAGE

This chapter analyzes production and storage trends in comparison to consumption patterns to determine the nature of surpluses and deficits. Table 8 presents corn and soybean acreage harvested, yield per acre, and production over the period. From the mid 1960's to the mid 1970's there was a 21.7 percent increase in corn acreage harvested and a 17.5 percent increase in yield per acre. Production increased 48.7 percent from 30 million bushels to 44.6 million.

Soybean acreage has increased 18.6 percent, and yields have increased from 19.9 bushels per acre to 23.1 bushels per acre or 16 percent over the two time periods. Increased acreage and yields resulted in a 38.5 percent increase in production from 7.2 million bushels in the earlier period to 10.0 million bushels in the later period.

Table 8. Annual Corn and Soybean Acreage, Yield and Production

Year	Corn			Soybeans		
	Acres Harvested (1000)	Yield (bu.)	Production (1000 bu.)	Acres Harvested (1000)	Yield (bu.)	Production (1000 bu.)
1965/66	494	68	33592	345	21	7072
1966/67	425	46	19550	355	19	6568
1967/68	485	73	35405	333	22	8234
1968/69	444	71	31524	372	19	7068
1969/70	444	77	34188	361	26	6780
1970/71	467	68	31756	338	20	6780
1971/72	480	68	32640	353	24	8472
1972/73	502	83	41666	350	23	8050
1973/74	550	84	46200	413	27	11151
1974/75	570	80	45600	430	24	10320
1975/76	565	88	49720	433	25	10825
1976/77	610	78	47580	398	21	8159
1977/78	560	550	30800	440	19	8360
1978/79	615	82	50430	455	28	12740
Average	515.4	72.9	37903.6	387.6	22.6	8798.9
Average 1965/69-1968/69	462.0	64.5	30017.8	363.8	19.9	7235.5
Average 1975/79-1978/79	562.5	75.8	44632.5	431.5	23.1	10021.0

In spite of increased production, Virginia remains a net feed deficit state in corn and soybeans. Table 9 contains production, use, and deficit on an annual basis for each crop. This table assumes that all corn and soybeans produced in Virginia are also consumed in Virginia. This consumption underestimates the actual deficit because a substantial, but unknown, quantity of both crops are exported. The corn deficit was 11 million bushels in the earlier period and 4.6 million bushels in the later period. Hence, as a percentage of production, the deficit decreased from 26.8 percent to 9.3 percent over the two time periods. The soybean deficit averaged 4 million bushels in the earlier period compared to 5.2 million bushels in the later period. These estimates disregard potential storage limitations which are considered in the next section.

Storage

In 1971 USDA began a data series in Grain Stocks which gives off-farm storage capacity by states. This off-farm capacity includes exporters, feed mills, processors, and terminal elevators which handle corn, soybeans, wheat, barley, rye, oats, and sorghum. In addition to these operations, peanut processors and seed dealers are included

Table 9. Annual Corn and Soybean Production, Use, and Deficit (in 1000 bu.) [a]

Crop Year	Corn			Soybeans		
	Production	Feed Use	Deficit	Production	Feed Use	Deficit
1965/66	33592	40028	-6436	7072.0	10717.6	-3645.6
1966/67	19550	41314	-21764	7568.0	11241.1	-4673.1
1967/68	35405	40703	-5298	8235.0	11219.1	-2985.1
1968/69	31524	42001	-10476	7068.0	11900.4	-4832.4
1969/70	34188	44708	-10520	9386.0	12651.0	-3265.0
1970/71	31756	44667	-12911	6780.0	12652.0	-5872.0
1971/72	32640	43278	-10638	8472.0	12430.4	-3958.4
1972/73	41666	42459	-793	8050.0	11844.1	-3794.1
1973/74	46200	43002	3198	11151.0	12244.8	-1093.8
1974/75	45600	44666	934	10320.0	13638.2	-3318.2
1975/76	49720	46614	3106	10825.0	14219.7	-3394.7
1976/77	47580	46778	802	8159.0	14800.0	-6641.0
1977/78	30800	48653	-17853	8360.0	14932.4	-6572.4
1978/79	50430	54795	-4365	12740.0	16939.8	-4199.8
Average	37903.6	44547.6	-6644.1	8798.9	12959.3	-4160.4
Average 1965/69-1968/69	30017.8	41011.4	-10993.5	7235.5	11269.5	-4034.1
Average 1975/79-1978/79	44632.5	49210.1	-4577.5	10221.0	15223.0	-5202.0

[a] These calculations assume all corn and soybeans produced in Virginia are fed in Virginia. This table does not include use for exports, industrial purposes or seed.

in the storage capacity. While stocks of grains are published quarterly by state, peanut stocks are not. Consequently, peanut storage had to be subtracted from the total capacity.

According to the major peanut processors and seed dealers in Virginia, the peanut storage capacity in off-farm facilities was approximately 100,000 tons or 8.889 million bushels as of 1978.[2]

To estimate total off-farm storage capcity from 1965 to 1970, the average annual percent increase was calculated from 1971 to 1978. The average increase in storage capacity was found to be 3 percent. To estimate the storage prior to 1971, the 1971 total and each previous year was reduced 3 percent. Peanut storage was subtracted from each year.

Table 10 gives on-farm, off-farm, and total storage capacity, October 1 stocks on-farm, off-farm, and total, and space available for storage of the corn and soybean crops for each year. Two things should be noted about the off-farm capacity figures. First, due to the lack of available estimates prior to 1978, it was assumed that peanut storage capacity remained constant over the study period. This assumption is not entirely accurate because some processors

---

[2]Based on telephone conversations with several Virginia peanut processors.

Table 10. Storage Capacity, Use, and Availability On and Off Farm (in 1000 bu.)[a]

Year	Capacity			Oct. 1 Stocks			Space Available for New Crop		
	On-Farm	Off-Farm	Total	On-Farm	Off-Farm	Total	On-Farm	Off-Farm	Total
1965	27628	8852	36480	6800	3640+[b]	10446	20828	5206	26034
1966	27628	9401	37029	6504	3812+	10316	21124	5589	26713
1967	31029	9967	40996	8397	5168+	13565	22632	4799	27431
1968	34429	10550	44979	10112	5057+	15169	24317	5493	29810
1969	34549	11151	45700	7919	4818+	12737	26630	6333	32963
1970	34669	11771	46440	8898	4872+	13770	25771	6899	32670
1971	34789	12511	47300	8124	5271+	13395	26665	7240	33905
1972	34809	13111	47920	3261	4786+	8047	31548	8325	39873
1973	34910	13111	48021	6553	2377	8930	28357	10734	39091
1974	36440	13611	50051	8847	3707+	12554	27593	9904	37497
1975	36844	17611	54455	7267	3746+	11013	29577	13865	43442
1976	37200	18711	55911	5638	2407+	8045	31562	16304	47866
1977	37556	20311	57867	7127	4191+	11318	30429	16120	46549
1978	37556	21031	58587	4270	2525+	6795	33286	18506	51792
Average 1965-1968	34288	13693	47981	7123	4024	11150	27166	9666	36831
Average 1965-1968	30179	9693	39871	7953	4419	12374	22225	5272	27497
Average 1975-1978	37289	19416	56705	6076	3217	9293	31214	16199	47412

[a] Excluding peanuts.
[b] +indicates totals are underestimated because of disclosure laws.

indicated they had increased their capacity since 1975. The impact of this assumption would be to overestimate the peanut storage and underestimate the grain storage prior to 1975. It was necessary to make the assumption due to a lack of data to determine how much of a change had occurred. Second, the storage capacity estimated by USDA includes export elevators, feed processors, flour mills, and processors, few of whom store for long periods of time but whose capacity is working space. These facilities were not subtracted from the total capacity because the quarterly stocks of grains reports include their holdings. If these facilities are not full as of October 1 when corn and soybean storage space is needed, the space available for harvest would be understated.

On-farm storage was estimated in 1978 by the Agricultural Stablization and Conservation Service (ASCS). As with off-farm storage, peanut storage was included in the total storage capacity. The survey was done on a county-wide basis with storage for grains and oilseeds aggregated. As a result, peanut storage could not be subtracted from the total and the on-farm storage overstates what is actually available for corn and soybeans. The 1978 ASCS survey is the only estimate of on-farm storage available. The following method was used to estimate capacity from 1965 to

1977. On-farm stocks reported quarterly were totaled by quarters. The greatest quantity was stored as of January 1. Using January 1, 1977, data, the stocks as a percent of on-farm capacity were calculated. The assumption was made that there was no change in storage capacity for grains and oilseeds from 1977 to 1978. January, 1977, was used because the 1977 crops were reduced substantially by drought and the result of comparing January, 1978, stocks to total capacity would produce an underestimate of the relationship and lead to a greater overestimate of on-farm storage. The January, 1977, stocks were 94 percent of storage capacity. Farm storage capacity for 1965, was calculated by multiplying the January 1, 1965 stocks by 106 percent. Each subsequent year that the January 1 stocks increased, they were multiplied by 106 percent on the assumption that decreases in January stocks would not lead to decreases in storage capacity. To fill in years where January stocks decreased, a linear trend was used.

Based on the preceding assumptions, there was a 42 percent increase in total storage capacity from the first to the second period. Off-farm storage doubled: from 9.7 to 19.4 million bushels. On-farm storage capacity increased 24 percent from 30 million bushels to 37.3 million bushels. In the earlier period off-farm storage represented 24 percent

of the total and 34 percent of the total in the later period.

The adequacy of storage at harvest time was calculated by comparing available storage capacity less October 1 stocks compared to the monthly harvest and consumption rates of corn and soybeans for October through December. Table 11 shows available storage space, bushels harvested, and consumption by month from October 1 to January 1. The rate of corn and soybean harvest by month is based on a 1972-78 average. By October corn harvest is 65.7 percent complete, an additional 22.4 percent occurs in November, and the remaining 11.9 percent in December. Soybean harvest occurs somewhat later with 20.9 percent being harvested during October, an additional 55.1 percent in November, and the remaining 24 percent in December (Virginia Agricultural Statistics). To determine available storage as of November 1, the October corn and soybean consumption was subtracted from the October harvest. The result was the quantity requiring storage. This quantity was subtracted from the storage available as of October 1, the result being the November 1 storage available. The same procedure was used for December 1 and January 1 storage availability.

At no time during the 14 years was there a shortage of storage during October. In only 4 of the 14 years (1965,

Table 11. Total Storage Available During Harvest for Corn and Soybeans (in 1000 bu.).

Crop Year	October 1 Storage Available	October Harvest	October Consumption	November Storage Available	November Harvest	November Consumption	December Storage Available	December Harvest	December Consumption	January Storage Available
1965	26034	23548	4097	6583	11422	4072	-767	8717	4082	-5402
1966	26713	14217	4289	16785	7998	4309	13096	3902	4291	13485
1967	27431	24982	4440	6889	12468	4390	-1189	6819	4437	-3571
1968	29810	22188	4298	11920	10955	4342	5307	5447	4402	4262
1969	32963	24424	4842	13381	12830	4949	5500	6321	5025	4204
1970	32670	22281	4693	15082	10849	4623	8856	5406	4694	8144
1971	33905	23215	4729	15419	11979	4565	8005	5917	4627	6715
1972	39873	29057	4712	15528	13769	4640	6399	6890	4677	4186
1973	39091	32684	4509	10916	16493	4445	-1132	8174	4467	-4839
1974	37497	32116	4856	10237	15900	4884	-779	7903	4953	-3729
1975	43442	34928	4932	13446	17102	5017	1361	8515	5161	-1993
1976	47866	32965	5076	19977	15154	5126	9949	7020	5239	8168
1977	46549	21983	5326	29892	11505	5226	23613	5671	5233	23175
1978	51792	35796	5836	21832	18316	5760	9276	9359	5895	5812
Avg. 1965/68	36830	26742	4760	14849	13339	4740	6250	6862	4799	4186
Avg. 1975/78	27497	21234	4281	10544	10711	4279	4112	6221	4278	2194
Avg.	47412	31418	5293	21287	15519	5282	11050	7716	5382	8716

1967, 1973, 1974) was storage inadequate for the crops harvested in November and in only one additional year (1975) for the crops harvested in December. When these shortages occurred, equal porportions of the corn and soybean harvests were stored after accounting for consumption. The effect of the inadequate storage with respect to production less consumption was that the 1973/1974 and the 1974/75 corn crops would have been adequate to meet the consumption needs had there been storage space available (compare Tables 9 and 11). At no time during the period studied has Virginia produced enough soybeans to adequately supply the needs of the livestock and poultry sectors. Consequently, the effect of the storage deficit in years other than 1973 and 1974 was to move forward the time when Virginia became deficit in corn and soybeans.

To calculate the month in which Virginia becomes deficit, the monthly consumption of corn and soybeans was subtracted from the estimated quantities of each in storage on January 1. The total deficit is the difference between estimated quantities stored and January through September consumption. Table 12 indicates that on the average Virginia becomes deficit in corn in July. The average deficit is 7.3 million bushels. For soybeans the deficit occurs in May and averages 4.7 million bushels.

Table 12. Storage, Consumption, and Total Surplus or Deficit of Corn and Soybeans

Crop Year	October 1 Available Storage Space	Estimated Quantity in Storage on January 1		Surplus or Deficit of Storage Space	Consumption Jan. through September		Month VA Becomes Deficit		Total Deficit or Surplus	
		Corn	Soybeans		Corn	Soybeans	Corn	Soybeans	Corn	Soybeans
1965/66	26034	22685.6	3347.9	-5402	30322.5	8166.0	July	April	-7636.9	-488.1
1966/67	26713	9267.5	3960.7	13485	31031.5	8633.8	March	May	-21764.0	-4673.1
1967/68	27641	23641.4	3789.6	-3571	30303.1	8351.8	July	May	-6662.0	-4512.2
1968/69	29810	21314.0	4262.2	4162	31790.0	9069.6	July	May	-10476.0	-4832.4
1969/70	32963	22583.1	6174.6	4204	33103.1	9439.6	July	June	-10520.0	-3265.0
1970/71	32670	20790.7	3734.1	8144	33701.7	9606.1	June	April	-12911.0	-5872.0
1971/72	33905	21796.8	5392.7	6715	32434.8	9351.1	July	June	-10638.0	-3958.4
1972/73	39873	30735.4	4951.8	4186	31528.4	8745.9	Sept.	May	-793.0	-3894.1
1973/74	39091	31775.6	7315.9	-4839	32512.0	9314.6	Sept.	June	736.4	-1992.0
1974/75	37497	32113.8	5384.6	-3729	33167.6	10443.2	Sept.	May	-1053.8	-5058.6
1975/76	43442	37042.0	6399.5	-1993	35103.6	10619.1	---[a]	June	1938.4	-421.6
1976/77	47866	35706.9	4590.0	8168	34904.7	11231.0	---	April	802.2	-6641.0
1977/78	46549	18785.0	4589.2	23175	36638.0	11161.6	May	April	-17853.0	-6572.4
1978/79	51792	36917.9	8672.2	5812	41282.9	12962.	Sept.	July	-4365.0	-4199.8
Average	36831	26082.6	5181.4	4186	33416.0	9792.5	July	May	-7333.5	-4396.2
1965/69 Average	27497	19227.1	3833.9	2159	30861.8	8555.3	June	May	-11634.7	-4721.5
1975/79 Average	47412	32113.0	6062.7	8716	36982.4	11493.5	Aug.	May	-4869.4	-5408.2

[a] Surplus, rather than deficit, exists as of September 30.

The average quantity of corn stored as of January 1 increased 68 percent from the first to the second time period. A 20.5 percent increase in consumption from January through September also occurred. The result of these respective increases was to delay the month when the deficit occurred from June until August and to decrease the deficit from 11.7 to 4.9 million bushels or by 41 percent.

For soybeans the situation is different. The quantity stored as of January 1 has increased from 3.8 to 6.1 million bushels or by 58 percent; consumption for January through September has increased by 34 percent. The deficit occurred in May for both time periods, but for the latter period it averaged 5.4 million bushels compared to 4.7 million bushels in the earlier period.

Total Production, Consumption, and Storage

A comparison of the annual deficit not considering storage (Table 9) and the annual deficit considering storage capacity (Table 12), indicates that only once during the 14 years of the study did the shortage of available storage space at harvest help create a deficit. Therefore, the deficit that occurs in corn and soybeans is the result of inadequate production to meet the needs of the livestock and

poultry producers, not inadequate storage space. This conclusion assumes that all of the corn and soybeans raised in Virginia remain in Virginia to be fed.

Several reminders are appropriate to guarantee the proper interpretation of the previous statements. First, although adequate storage is available on a statewide basis, for any given location in the state it may not be adequate to handle the magnitude of the production or there may be a surplus of storage with respect to the production level. Second, there are some obvious overestimates in the availability of storage. Third, the approach used does not consider exports. If part of Virginia's corn and soybean crops are exported, which they are (Leath, et al. and Hill, et al.), then the deficits would show up earlier than indicated by Table 12 and the years when corn appeared as surplus may, in fact, have been deficit also. Again, data for more than one year are not available to make such a determination.

Chapter IV

ECONOMIC ANALYSIS

There are two possible solutions to Virginia's feed deficit problem: 1) Virginia could increase its corn and soybean production, or 2) it could import additional corn and soybeans from some surplus area such as the Midwest. The purpose of this section is to determine if the price paid at various surplus areas within the state plus transportation to the closest deficit area is less than, equal to, or greater than the Midwest price plus transportation to the deficit areas of Virginia. If the price in the deficit areas plus transportation from the surplus areas within the state is less than the price plus transportation from the Midwest, production of corn and soybean could be increased in Virginia if they are profitable crops compared to the other alternatives available to producers.

Procedures

Surplus and deficit regions within the state were determined as follows. First, the state was divided into nine regions based on similarity of crop production.[3] (See Figure 5 for regions. Twelve of the counties in the most southwestern part of Region IX have been omitted from the map. These counties include: Bland, Buchanan, Dickerson, Grayson, Lee, Russell, Scott, Smythe, Tazewell, Washington, Wise, and Wythe). Total corn and soybean production in 1978 for each region was calculated based on data from Virginia Agriculture Statistics, 1980. The 1978/79 crop year was used for three reasons: first, it is typical of production with average yields of 82.0 and 28.0 bushels per acre for corn and soybeans, respectively; second, the 1978 fuel costs increased to over $1 per gallon which are representative of current fuel costs; and third, in 1978 ASCS surveyed, by county, on-farm and off-farm storage capacity, the only existing data on county storage capacity.

Second, regional consumption was calculated by totaling county animal numbers for each crop region. This total was

---

[3]Based on information provided by Dr. Daniel Brann, Agronomy Extension Specialist, VPI&SU.

then figured as a percentage of the state total for each animal category. The percent the individual livestock or poultry numbers were of the state total was then multiplied by the total state-wide consumption. In instances where no numbers were reported due to disclosure laws, the residual labelled "other" was divided as a weighted average among the regions where this information was relevant. The weighted average was based on the percentage of counties within the region that were not reported for disclosure purposes.

The third step in the process was to determine the location, by region, of storage capacity based on the 1978 ASCS survey. The inclusion of peanut storage in the data necessitated reduction of off-farm storage by the amount used for peanuts. All of the peanut processors contacted are located in Norfolk-Southeast or Region I (Figure 5). According to Extension personnel, there is a limited amount of processing in Farmville or Region VI, probably less than 5 percent of the state total.[4] As a result, all of the peanut storage was assumed to be located in the Norfolk-Southeast region. The effect of this assumption does not result in a storage deficit in Farmville (VI) even if the off-farm storage is reduced by 5 percent. To determine

---

[4]Thomas Lavery, Virginia Crop Improvement Association, VPI&SU.

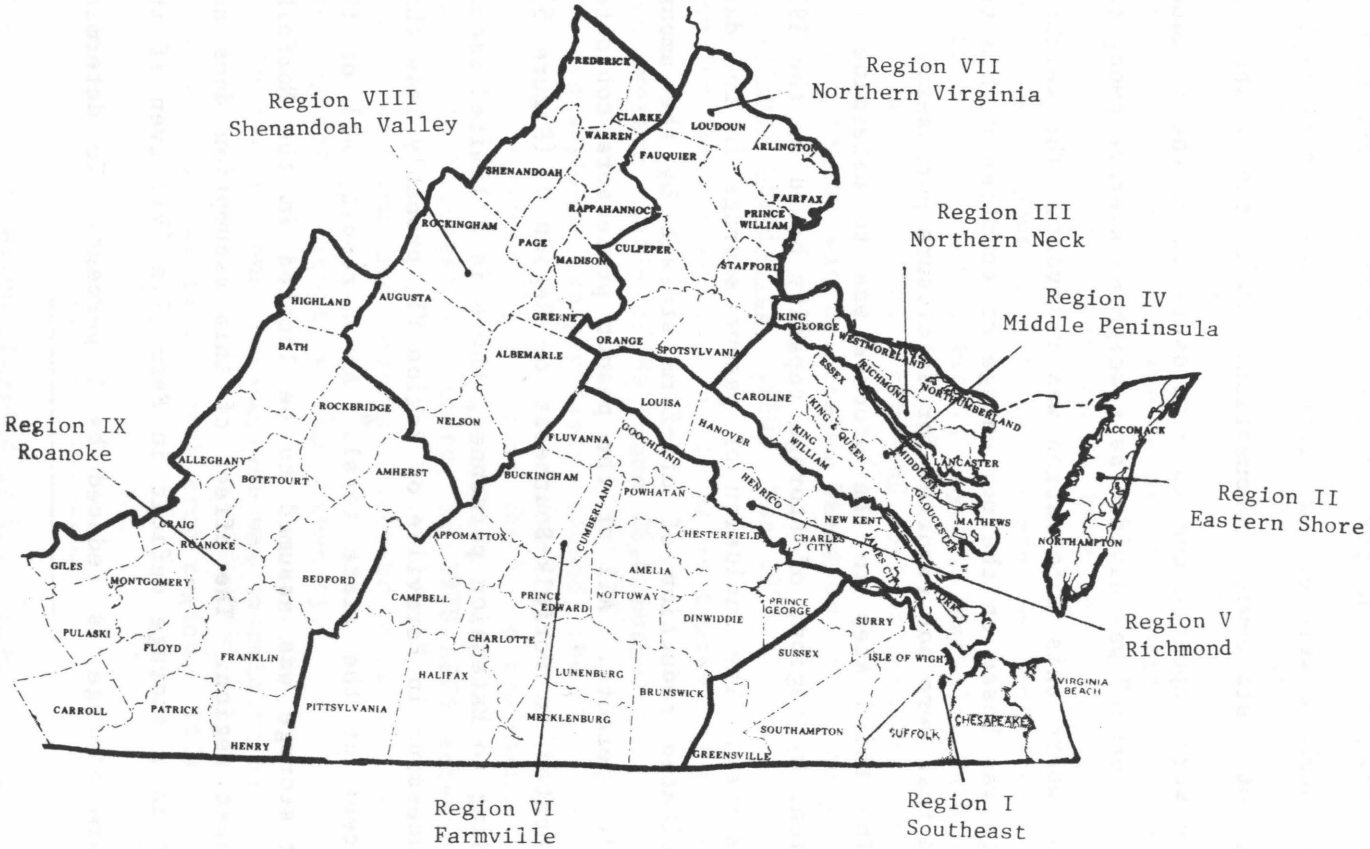

Figure 5. Crop Production Regions

available space as of October 1, the total October 1 stocks, on-farm and off-farm, were figured as a percent of the on-farm and off-farm storage capacity in each region. This percentage was then multiplied by the state total for October 1 stocks (Table 13). To determine if there was a deficit or a surplus of storage capacity available by the end of harvest, the October through December regional feed consumption was subtracted from the total regional production and compared to the October 1 storage available. If a deficit in regional storage existed, the same procedure as previously described for determining the quantity of corn and soybeans stored was used.

Fourth, weekly prices reported by Virginia Market News for major markets within each region were used to obtain a season average price for corn. The markets used were Norfolk and Southeast for Region I, Eastern Shore for Region II, Northern Neck for Region III, Middle Penninsula for Region IV, Richmond for Region V, Farmville for Region VI, Northern Virginia for Region VII, Shenandoah Valley for Region VIII, and Roanoke for Region IX. The season average price for corn in Columbus, Ohio, was used to represent the cost of corn imported into Virginia. The Decatur, Illinois, season average price for 44 percent soybean meal was used since all processors indicated that they priced soybean meal

Table 13. Regional Total Storage Capacity, October 1 Stocks, and Storage Capacity Available 1 October (1000 bu.)

Region	Storage Capacity[a]			Oct. 1 Stocks[b]			Space Available Oct. 1
	On-farm	Off-farm	Total	On-farm	Off-farm	Total	
I	11153	6409[c]	17562	1271.4	769.1	2040.5	15521.5
II	967	607	1574	110.2	72.8	183.0	1391.0
III	1726	1685	3411	196.8	202.2	399.0	3012.0
IV	2224	3276	5500	253.5	393.1	646.6	4853.4
V	2453	1464	3917	279.6	175.7	455.3	3461.7
VI	8140	2401	10541	928.0	288.1	1216.1	9324.9
VII	4213	3170	7383	480.3	380.4	860.7	6522.3
VIII	4784	1222	6006	545.4	146.6	692.0	5314.0
IX	1896	875	2771	216.1	105.0	321.1	2449.9

[a]Source: Calculations by region based on Grain Storage Capacity Survey, USDA, ASCS, Oct. 1978.

[b]Source: Calculations based on % Oct. 1 stocks for state were of total state on-farm and off-farm storage capacity.

[c]Capacity available after subtracting peanut storage space.

FOB Decatur plus a Virginia basis. Transportation rates from Columbus and Decatur to all regions in Virginia were obtained.[5] Rates for shipping corn within the state were associated with either rail, truck, or barge. Truck rates were based on information from processors and producers or calculated based on the equation

$$\frac{\$1.90}{800 \text{ bushels}} \times \text{number of miles} = \text{cost per bushel.}^{6}$$

Barge rates were obtained from processors. To calculate the cost of Virginia produced grain's being moved within the state, the least cost method of moving the corn from surplus to deficit areas was added to the price in the surplus location. Transportation rates between deficit and surplus regions are shown in Table 14.

Regional Consumption, Production, and Storage

Table 15 shows the relationship among production, consumption, and storage on a regional basis. Storage is restrictive in terms of production on the Eastern Shore

---

[5]These rates are based on shortest haul any carrier and were provided by Norfolk and Western Railroad.

[6]Russ Walls, Southern States Cooperative.

(II), Northern Neck (III), and Middle Penninsula (IV). The assumption of storing equal quantities of corn and soybeans is probably not valid for the Eastern Shore (II) since at the end of the crop year there was a surplus of soybeans and a deficit of corn. When comparing corn production to consumption, the deficit was 779.5 thousand bushels. Table 15 shows a deficit of 1150.2 thousand bushels resulting, in part, from inadequate storage. If unequal quantities of

Table 14. Transportation Rates for Corn Moved Within Virginia (cents/bu.)

Surplus Region		Deficit Region II	VI	VIII	IV
I	R	36	36	40	38
	T	---[a]	30	52	35
	B	17	---	---	---
III	R	42	36	37	42
	T	---	30	37	57
	B	15	---	---	---
IV	R	43	36	42	43
	T	---	18	39	43
V	R	40	36	40	42
	T	44	24	29	38
VII	R	52	52	36	50
	T	---	52	24	50
Columbus, OH.	R	91	61	34	51

R = rail rate
T = truck rate
B = barge rate
[a] - indicates not applicable

corn and soybeans were stored, the result would be a corn deficit of 806.1 thousand bushels and no surplus of soybeans, indicating that there is still a storage deficit as well as a production deficit. The Northern Neck (III) and Middle Penninsula (IV) have storage deficits with respect to production, but still have available more than is consumed within their respective regions.

If what could not be stored on the Eastern Shore (II), Northern Neck (III), and Middle Penninsula (IV) were exported from the state, then in 1978/79 the corn deficit would have been 8.8 million bushels compared to -4.4 million bushels if all that was produced in Virginia were to remain in the state. For soybeans the deficit was 7.1 million bushels if what could not be stored where it was produced were exported from the state compared to -4.2 million bushels if all were to remain in Virginia for feed consumption.

Corn Movement

A linear programming algorithm was used to determine the least cost source of corn for the deficit regions in Virginia. Two models were considered. The first model assumes all corn produced in Virginia must be consumed in Virginia before corn can be imported from Ohio. The second

Table 15. Region Storage, Production, Consumption, and Total Deficit or Surplus for 1978/79 Crop Year (1000 bu.)

Region	Total Storage Available 1 Oct.	Total Prod.		Oct.-Dec. Consump.		Est. Quantity Stored 1 Jan.		Jan.-Sept. Consump.		Deficit/Surplus	
		Corn	Beans	Corn	Beans	Corn	Beans	Corn	Beans	Corn	Beans
I - Southeast	15521.5	12829.8	3110.9	2424.1	555.0	10405.7	2555.9	6631.8	1589.4	3773.9	966.5
II -Eastern Shore	1391.0	1250.3	1961.8	447.4	180.4	432.2	958.8	1582.4	659.7	-1150.2	229.1
III -Northern Neck	3012.0	4459.0	1783.8	175.5	36.9	2139.5	872.5	468.4	103.9	1671.1	768.6
IV - Middle Pen.	4853.4	5355.7	2306.3	283.6	64.3	3365.7	1487.7	778.3	184.5	2582.4	1303.2
V - Richmond	3461.7	2651.0	920.5	392.0	95.2	2259.0	825.3	1104.1	286.6	1154.9	538.7
VI - Southside	9324.9	8019.9	2250.0	2187.0	628.4	5932.9	1621.6	6556.2	2032.2	-723.3	-410.6
VII - Northern Va.	6522.3	6105.8	345.9	633.7	132.8	5472.1	213.1	1726.5	384.2	3745.6	-171.1
VIII- Shenandoah	5314.0	5654.9	38.7	5256.7	1862.5	98.2	-1823.8	17618.3	6469.2	-17520.1	-8292.0
IX - Southwest	2449.9	4103.6	22.2	1691.9	410.6	2411.7	-388.4	4718.9	1210.2	-2307.2	-1598.6

[a]Oct.-Dec. and Jan.-Sept. Consumption does not equal state totals for the same periods due to rounding.

model permits deficit regions to buy corn from the cheapest source. The price in each deficit region was calculated based on the price in each surplus region plus transportation cost by the least costly mode. The computed prices differ from actual season average prices for the deficit regions because the transportation rates are estimates based on 1981 figures. Data on 1978 transportation rates were unavailable. The prices in surplus regions and transportation costs to deficit regions are shown in Figure 6.

In model I the cost of the corn plus transportation is $61.313 million for the 21.7 million bushels that must be moved from one region to another. Table 16 shows the source and quantity of the corn that is shipped, where it is shipped to, and the price paid in the deficit region. The results indicate that the Eastern Shore (II) would buy from Norfolk-Southeast (I); that Farmville (VI) would buy from Richmond (V); that the Shenandoah Valley (VIII) would buy from all surplus regions in the state as well as Ohio; and that Roanoke (IX) would buy from Norfolk-Southeast (I). The result is higher prices being paid by the Eastern Shore (II), Shenandoah Valley (VIII), and Roanoke (IX) than would be paid if corn were not constrained to move within the state first.

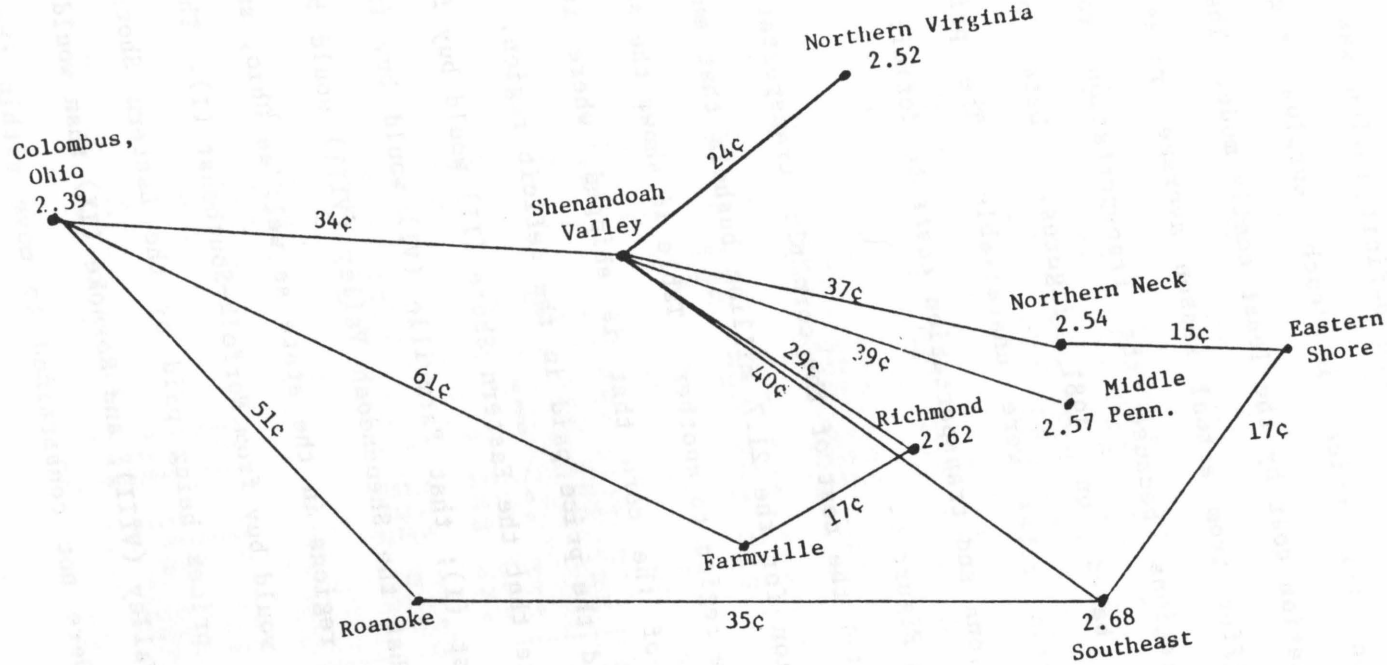

Figure 6. Corn Price and Transportation Rates

Table 16. Corn Movement in Virginia

Model I. Virginia Production Consumed Prior to Importing from Ohio

Origin	Destination	Quantity Shipped (1000 bu.)	Price at Destination ($/bu.)
Region I	Region II	1150.2	2.85
	Region VIII	316.5	3.08
	Region IX	2307.2	3.03
Region III	Region VIII	1671.1	2.91
Region IV	Region VIII	2587.4	2.96
Region V	Region VI	723.3	2.79
	Region VIII	431.6	2.91
Region VII	Region VIII	3745.6	2.76
Columbus, OH.	Region VIII	8767.9	2.73

Model II. Purchase Corn from Cheapest Source

Region III	Region II	1150.2	2.69
Region V	Region VI	723.3	2.79
Columbus, OH.	Region VIII	17520.1	2.73
	Region IX	2307.2	2.90

Model II relaxes the constraint of using all Virginia produced corn first and permits the deficit regions to purchase corn from the cheapest source. Under these assumptions, the Eastern Shore (II) buys from the Northern Neck (III); Farmville (VI) buys from Richmond (V); and the Shenandoah Valley (VIII) and Roanoke (IX) buy from Ohio. The quantities traded and delivered prices in deficit regions are shown in Model II of Table 16. The total cost of corn plus transportation is $59.6 million, or a reduction of $1.7 million compared to Model I. This reduction in costs is approximately 8 per bushel. Analysis of Figure 6 indicates why the Shenandoah Valley (VIII) and Roanoke (IX) import from Ohio rather than from Virginia's surplus regions. The delivered price in the Shenandoah Valley (VIII) from Ohio is $2.73. The delivered price from Virginia's surplus regions is Northern Virginia (VII) $2.76, Northern Neck (III) $2.91, Richmond (V) $2.91, Middle Penninsula (IV) $2.96, and Southeast (I) $3.08. In Model I, the 8.8 million bushels purchased by the Shenandoah Valley (VIII) from surplus areas in Virginia had an average delivered price of $2.87 per bushel. Purchasing this quantity from Ohio rather than from Virginia saves the Shenandoah Valley (Region VIII) 14 per bushel. Similar

calculations indicate Roanoke (IX) saves 13 per bushel by buying from Ohio instead of Norfolk-Southeast (I).

Since it is less costly for the Shenandoah Valley (VIII), the major corn deficit region, to obtain corn from Ohio than from Virginia, the implication is that the lower Ohio price reflects a comparative advantage in production over Virginia. This study has not dealt with the relative costs of production in Ohio and Virginia. To be more complete costs would need to be compared. It would appear, however, that unless the price of corn in Virginia decreases relative to Ohio's or unless Ohio corn prices increase relative to Virginia's, or unless there is a significant change in transportation rates within the state, increasing Virginia's corn production for livestock and poultry consumption within the state is not feasible.

An estimate of exports in 1978/79 can be obtained by comparing the solutions of models I and II. This comparison indicates all surplus regions in Virginia are left with some corn not consumed in that region. Since all of these regions are relatively close to either Norfolk or Baltimore, it is hypothesized that this corn is exported.

Soybean Meal Pricing and Movement

Soybeans are produced in all nine regions of the state. However, before they are consumed by livestock and poultry, they must be processed into soybean meal. There are soybean meal processors in Norfolk, Virginia; Salisbury, Maryland; Millsboro, Delaware; and Raleigh and Fayetteville, North Carolina. The question of why Virginia does not produce more soybeans ultimately becomes tied to soybean meal prices. Processors price soybean meal FOB Decatur plus a basis or differential for Virginia. For example, the season average price in 1979 for 44 percent soybean meal FOB Decatur was $203.51 per ton (Statistical Annual 1978). The season average price for soybean meal bought from Fayetteville, North Carolina by a Virginia livestock or poultry producer would be $203.51 per ton plus a Virginia basis of $12 (Cargill, Fayetteville, N.C.) plus transportation costs. Transportation rates are based on the cost of shipping the meal from Decatur whether it is purchased in Decatur or Fayetteville. Thus, a buyer from Harrisonburg, Virginia, would pay $203.51 per ton plus $29 per ton shipping if he were to purchase from Decatur. If, however, he were to purchase from Fayetteville, he would still pay $203.51 per ton plus $29 per ton shipping, and an

additional $12 per ton basis for a total of $244.51 per ton (Figure 7). Basis will vary depending upon where in the state the meal is being shipped and on how much the processor has to sell. The basis given in Table 17 represent averages for the processors to move meal from the plant to any location in Virginia.

Given the pricing mechanism for soybean meal -- FOB Decatur, plus Decatur transportation rates, plus a Virginia basis -- the least cost source for soybean meal for each region in Virginia is Decatur (Table 17). The implication is that Decatur has a comparative advantage in processing meal. It also leads to the conclusion that the price of soybeans is not high enough relative to production costs or opportunity costs to provide an incentive for increased production in Virginia for the purpose of processing soybeans into soybean meal. As with corn, this research has not directly addressed a cost analysis nor has it addressed the opportunity cost of producing soybeans for the export market.

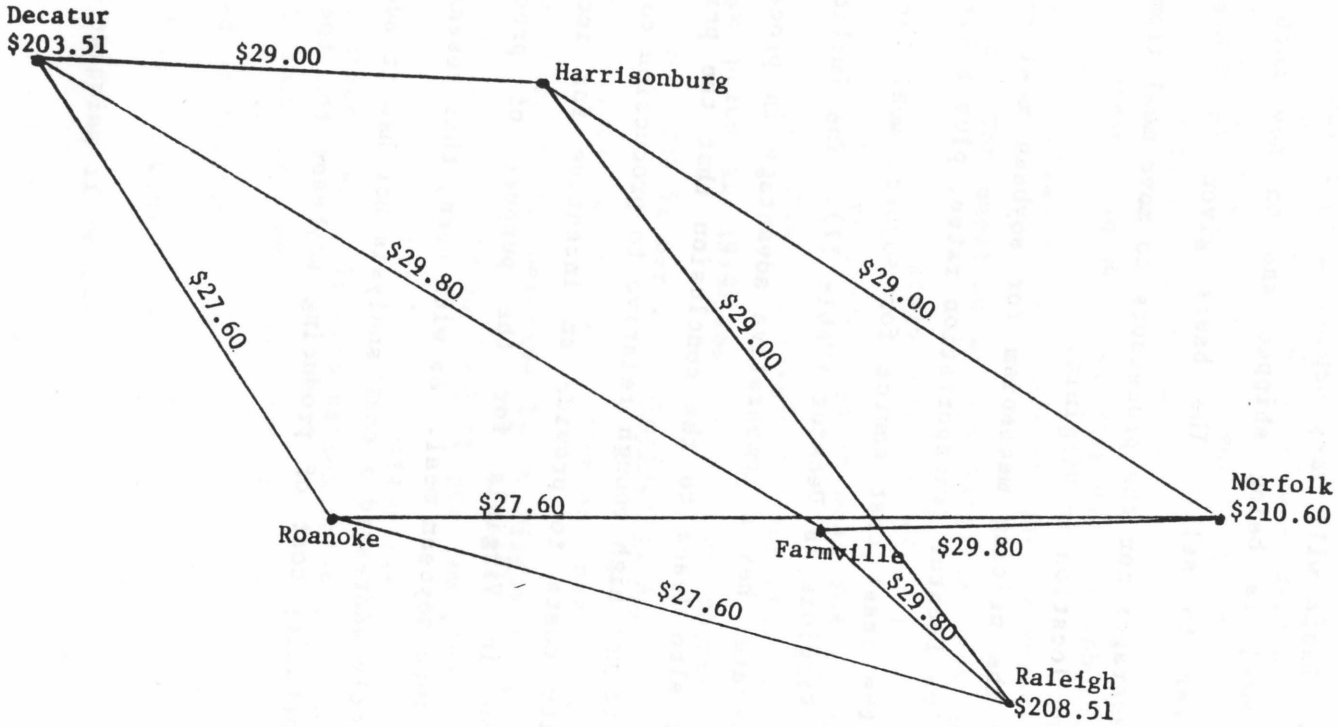

Figure 7. Soybean Meal Prices and Transportation Rates

Table 17. Decatur Price, Decatur Transportation Rates, Virginia Basis and Delivered Price ($/ton 44% SBM)

Region	Decatur Price	Transportation Cost	Delivered Price	Fayetteville Basis	Delivered Price	Norfolk Basis	Delivered Price	Raleigh Basis	Delivered Price
	203.51			+12.00		+7.00		+5.00	
I		34.40	237.91		249.91		244.91		242.91
III		39.60	243.11		255.11		250.11		248.11
IV		41.40	244.91		256.91		251.91		249.91
V		34.20	237.71		249.71		244.71		242.71
VI		29.80	233.31		245.31		240.31		238.31
VII		31.60	235.11		247.11		242.11		240.11
VIII		29.00	232.51		244.51		239.51		237.51
IX		27.60	231.11		243.11		238.11		236.11

Chapter V

Summary and Conclusions

The total consumption of both corn and soybeans as feed has increased over the last 15 years. Corn consumption increased 20 percent from 41.0 million bushels to 49.2 million bushels as a result of changes in the livestock and poultry sectors. From the 1965-1969 period to the 1975-1979 period, corn consumption by broilers increased 77 percent, by turkeys 140 percent, by hogs 9 percent, by cattle on feed 46 percent, by beef 47 percent, and by horses 25 percent. Corn consumption by all other livestock and poultry categories decreased over the same period: by layers 20 percent, by dairy 39 percent, and by sheep 24 percent. These increases and decreases in consumption resulted in changes in the relative percent of total consumption by each livestock category. Specifically, consumption by broilers increased from 18 to 23 percent and by turkeys from 7 to 14 percent. Consumption by hogs decreased from 42 to 38

percent by layers from 14 to 8 percent, and by dairy from 10 to 8 percent. Consumption by all other livestock categories remained relatively unchanged when compared to total consumption of corn.

Total soybean meal consumption has increased from 11.3 million bushels in the earlier period to 15.2 million bushels in the later period -- an increase of 35 percent. Poultry are the primary consumers of soybean meal. In the earlier period turkeys, broilers, and layers consumed 55 percent of the total. In the later period they consumed 61 percent of the total. While soybean meal consumption by layers has decreased due to decreasing numbers, the increase in turkey and broiler numbers has resulted in an overall increase. Increased numbers resulted in a 76 percent increase in soybean meal consumption by broilers. Turkey consumption of soybean meal increased 139 percent. Soybean meal consumption by hogs increased 12 percent, by beef 47 percent, by cattle on feed 46 percent, and 25 percent by horses. Although corn consumption by dairy cows has decreased, soybean meal consumption has increased 11 percent, resulting from an increased use of soybean meal in the ration as well as an increase in feed fed per cow. Soybean meal consumption decreased 20 percent by layers and

24 percent by sheep. As with corn, these changes in consumption of soybean meal by each livestock and poultry category have led to shifts in the percentage each is of the total soybean meal consumption. Consumption by all poultry increased from 55 to 61 percent, with that by layers decreasing from 20 to 12 percent and by broilers and turkeys increasing from 26 to 33 percent and from 9 to 16 percent respectively. Soybean meal consumption by hogs decreased from 32 to 27 percent of the total. Consumption by all other livestock categories remained relatively unchanged with respect to total consumption from the earlier period to the later period.

Production of both corn and soybeans has increased. Some of this increase can be attributed to the introduction of higher yielding varieties; some of it is attributable to increased acreage harvested. Corn production increased 48.7 percent from 30.0 million bushels to 44.6 million bushels over the two time periods. Soybean production increased from 7.2 million bushels to 10.0 million bushels or 38.5 percent.

The increase in corn production has reduced the corn feed deficit from 11.0 million bushels to 4.6 million bushels, assuming all corn produced within the state is

consumed within the state. The 11.0 million bushel deficit of the earlier period represents a deficit, relative to production, of 26.8 percent. The same relationship of deficit to production in the later period is 9.3 percent. Relative to production, the soybean deficit has decreased by 1.6 percent from the earlier to the later period.

In the earlier period the deficit was 4.0 million bushels or 35.8 percent of the production. In the later period, the deficit increased to 5.2 million bushels, or 34.2 percent of the total production.

Available storage space was not, on the average, a restrictive factor in either period. The storage space available for harvest starting in October averaged 27.5 million bushels in the earlier period compared to 47.4 million bushels in the later period: an increase of 72 percent. Storage space on January 1 after harvest had been completed averaged 2.2 million bushels in the mid 1960's compared to 8.7 million bushels in the mid 1970's.

Given the changes in production and consumption trends, there has been a subsequent change in the months when Virginia becomes deficit in corn. In the earlier period, corn had become deficit by June, whereas in the later period

the deficit did not occur until August. The deficit in soybeans occurred in May in both periods.

When production, consumption, and storage are considered on a regional basis, the picture changes. Storage does become restrictive on the Eastern Shore (II), the Northern Neck (III), and the Middle Penninsula (IV). If no storage deficit had occurred during the 1978/79 crop year, the corn and soybean deficits would have been 4.5 million bushels and 4.2 million bushels, respectively. However, the effect of storage restrictions in the three regions resulted in deficits of 8.8 million bushels and 7.1 million bushels respectively. The least cost solution for deficit corn regions in Virginia resulted in 19.8 million bushels being imported from the Midwest. When deficit areas in Virginia are forced to purchase all surplus corn in Virginia before purchasing from the Midwest, imports drop to 8.8 million bushels. The additional cost of buying Virginia instead of Midwest corn in 1978/79 was about 8 per bushel, or $1.7 million.

Based on the analysis of Virginia prices and transportation costs (soybean meal is priced FOB Decatur plus a basis for Virginia plus transportation costs based on

shipment from Decatur) soybean meal consumed in Virginia can be purchased at lower delivered prices from Midwest than from Virginia processors. Consequently, increasing the production of soybeans in Virginia for the purpose of feeding Virginia livestock and poultry is not likely to occur. The results for corn, based on a local price plus transportation costs to the deficit areas in Virginia, show that shipping within the state is more expensive, in most cases, than importing from the Midwest. Thus, increased production of corn would not be likely to reduce the feed deficit unless it could be produced in the deficit regions.

References

Hill, Lowell D., Mack N. Leath, and Stephen W. Fuller. Corn Movements in the United States: Interregional Flow Patterns and Transportation Requirements in 1977. Ag. Exp. Stat., Dept. of Ag., U. of Ill. at Urbana-Champaign, Jan. 1981.

Leath, Mack N., Lowell D. Hill, and Stephen W. Fuller. Soybean Movements in the United States: Interregional Flow Patterns and Transportation Requirements in 1977. Ag. Exp. Stat., Dept. o f Ag., U. of Ill. at Urbana-Champaign, Jan. 1981.

Mundy, Karen P. "Consumption, Production, Storage, and Movement of Corn and Soybeans in Virginia." Unpublished MS thesis, Virginia Polytechnic Institute and State University, June 1982.

National Research Council. Nutrient Requirements of Domestic Animals, No. 2 Nutrient Requirements of Swine. National Research Council, Washington, D.C., 1978, various years.

Statistical Annual 1978. Chicago: Chicago Board of Trade 1978.

U.S. Department of Agriculture. ASCS. Grain Storage Capacity Survey. Washington, D.C., October 1978.

U.S. Department of Agriculture. ESC. Hogs and Pigs Reports: A Handbook on Surveying and Estimating Procedures. Washington, D.C., Statist. Bull. 66, August 1979.

_____. Hogs and Pigs Report: Final Estimates. Washington, D.C., various issues.

_____. Livestock and Meat Statistics. Washington, D.C.; AMS Statist. Bull. 522, various issues.

Van Arsdall, Roy N., Structural Characteristics of the U.S. Hog Production Industry. USDA. ESCS. Ag. Econ. Report No. 415, December 1978.

Virginia Department of Agriculture and Consumer Services. Virginia Agricultural Statistics. Richmond, Va., Va. Coop. Crop Reporting Service Bull. No. 44, various years.

_____. Farm Price Weekly. Richmond, Va., Federal-State Market News Service, various issues.

Virginia's Agricultural Experiment Stations

1—Blacksburg
Virginia Tech

2—Steeles Tavern
Shenandoah Valley Research Station

3—Orange
Piedmont Research Station

4—Winchester
Winchester Fruit Research Laboratory

5—Middleburg
Virginia Forage Research Station

6—Warsaw
Eastern Virginia Research Station

7—Suffolk
Tidewater Research and Continuing Education Center

8—Blackstone
Southern Piedmont Research and Continuing Education Center

9—Critz
Reynolds Homestead Research Center

10—Glade Spring
Southwest Virginia Research Station

11—Hampton
Seafood Processing Research and Extension Unit