The Origin of Forage Research in Texas

Dr. Ethan C. Holt

Soil and Crop Sciences Department

Texas Agricultural Experiment Station

Dr. Ethan C. Holt was born February 6, 1921, in Brilliant, Alabama. He served in the U.S. Army in World War II as an infantry officer in Europe and was awarded the Bronze Star for "Bravery under Fire Beyond the Call of Duty." Dr. Holt earned a B.S. in agriculture in 1943 from Auburn University, a M.S. in 1948 from Purdue University, and a Ph.D. in 1950 from Purdue University, with both graduate degrees in plant breeding. In the meantime, Dr. Holt came to Texas A&M in 1948 as an Assistant Professor, which was a position that he held until 1954, when he was promoted to Associate Professor, and three years later, to Professor, in the Soil and Crop Sciences Department. Dr. Holt's professional interests were three-fold: Plant Biology Environmentally, Plant Biology-Applied, and Plant Genetics. He was a member of the American Society of Agronomy, Crop Science Society of America, and the American Association for the Advancement of Science.

Dr. Holt was the ***original forage researcher*** in Texas. In January 1976, he was interviewed by Texas Agricultural Experiment Station Research Historian Dr. Irvin M. May, Jr., and discussed the initiation of forage research in Texas. The following is an excerpt of that interview.

(*Dr. Ethan Holt, 1976*) "In terms of history, formalized Forage Research at the Texas Agricultural Experiment Station didn't start until about the mid-1930's. Prior to that, there had been some work done primarily in the way of Introduced grasses and legumes. Going back to the very early 1900's there had been introductions of grasses and legumes that had been planted at various locations in the state. I'm sure, prior to 1936, there was also some

general agronomic work with forages, but the first formalized Texas Agricultural Experiment Station Project was written by R. L. Hensel about 1935 or 1936.

Mr. R. L. Hensel organized and wrote the first Experiment Station Project. In 1948, when I joined the Texas Agricultural Experiment Station, one of the first things that we did was to move plot material from the Hensel Park Area to what we call the Airport Nursery which is now part of the Easterwood Airport. Sometime within two or three years after the initiation of the forage research program, George C. Warner joined this group as a graduate student with a plant breeding interest, and he worked prior to World War II and also for a short period following World War II with several introduced grasses. George later started Warner Seed Co.

In addition to the work with Introduced species locally, the early program also involved a considerable amount of Rangeland work. One aspect particularly that was conducted by the Agronomy Department, and I presume this was prior to the time there was a Range Science Department, was the Phosphorus work on the King Ranch. Actually, E. B. Reynolds (TAES, Head of Agronomy Division) wrote the Bulletin on this subject, but the work was started by Mr. Hensel and his coworkers and was directed towards determining whether the phosphorus deficiency that occurs in cattle in the Gulf Coast could be corrected by the application of phosphorus fertilizers to the soil or to the grass. Also, it involved looking at the vegetational changes that occurred with fertilization. This work was carried on until about 1950. King Ranch had an animal husbandryman by the name of Lowell Tash who cooperated in the program and was responsible for maintaining the research areas, though I never had the opportunity to meet him. The co-authors of the publication, "Methods of Supplying Phosphorus to Range cattle in South Texas," (TAES Bulletin 773) were E. B. Reynolds, J. M. Jones, J. H. Jones, J. F. Fudge, and R. J. Kleberg, Jr. It is my understanding that Bob Kleberg (RJK, Jr.) was the individual instrumental in cooperating in these studies.

There was parallel or similar work at the Angleton Station, (Sub-Station No. 3) and in this case, started by a man who was Superintendent at the time. His name was R. M. Stansel.

That's Jim Stansel's father. (Jim was Scientist in charge, TAES Agricultural Research and Extension Center at Beaumont's Western Division at Eagle Lake).

Angleton Grass came in through the Introduction Program. It is one of the introduced Asiatic or exotic Bluestems. As far as I know, Angleton Grass evolved from having been evaluated and found to be well adapted at the Angleton Station. The grass itself has never had a major impact because of the poor seed production characteristics even though it has been found, with a minimum of irrigation, to be a well adapted grass to the heavy soils in the Gulf Coast and also in the lower Rio Grande Valley. It has never had very much of an impact for pastures.

King Ranch Bluestem. I'd have to look this up, but I believe now the "kind" designation of King Ranch Bluestem is Yellow Beardgrass. But, anyway, it ended up with King Ranch Bluestem being the one that was distributed and planted probably on more acres than any other one grass in Texas. It is a very good soil stabilization grass in terms of producing a protective cover, but it has some unfavorable characteristics in terms of forage nutritive value. There could be some debate certainly about its contribution to pasture. I don't think there is any question about its value for protecting the soil.

Because of the interest in cool-season perennial grasses, my assignment when I came here was to work on cool-season perennial grasses. We started out with **Tall Fescue** which was adapted to the Great Plains and North Central United States. The work had started prior to the drought years of the late 1940's, and it continued into the mid-1950's, at which time it was decided that perennial cool-season grasses really had little adaptation or little opportunity of surviving through the summers under our conditions.

Let me comment on **Wintergreen Hardinggrass**. By way of background and history, we go back to the fact that perennial, cool-season grasses did not appear to be well adapted, because under the extreme drought conditions in the early 1950's, most of them went out. It was found that Hardinggrass had some potential under these conditions in that it goes dormant in summer and will survive hot dry summers better than most other perennial cool-season grasses. Out of introductions tested at the McGregor Station (Sub-Station No 23) in 1951 and 1952, a few perennial cool-season grasses survived the drought period of 1952,

1953, 1954, and 1956. Material was selected from surviving plants, evaluated, intercrossed and eventually named '**Wintergreen Hardinggrass**' as a perennial cool-season grass. Its primary area of adaptation is in the Blackland area where there is generally found good spring and fall, and perhaps even winter, rainfall but very limited summer moisture, and where the summer survival is a problem on most cool-season plants. Wintergreen is best adapted in this area.

How effective have we been in communicating our scientific work with grasses to these ranchers? In terms of new grasses, you don't have to communicate to them, they'll communicate with you.

Much of our effort beginning in 1948 involved the cooperation at numerous locations in the state and one that we were involved in specifically was Crystal City, TX, Prior to the time Dr. Carl Hoveland (First Forage Research Agronomist at Crystal City) was employed, we did considerable forage work in terms of species evaluation and some seed production work to determine whether it was possible to develop the Winter Garden Area as a grass seed production area. In addition to work at Crystal City, we were also involved in working at Nacogdoches, Lufkin, Mt. Pleasant, and a few years later, at Temple (Sub-Station No 5), when forage was developed there. Then we did cooperative work at Kirbyville. We also cooperated in work at Tyler with P. R. Johnson (former Superintendent TAES, at Tyler; Sub-Station No 2) where we were looking at methods of establishing grasses, fertility practices influencing production, and stand survival.

Let me start again about the mid-1950's. In our local work we started a Cytogenetics Program along with the regular forage breeding and management programs. The cytogenetic program was in cooperation with the Forage and Range Research Branch of the United States Department of Agriculture and specifically with Dr. E. C. Bashaw who has been a co-worker of mine (with the exception of about three years) since 1946.

We had a basic program on the cytology and method of reproduction of **Dallisgrass**.

We found that it reproduced by apomixis, which is reproduction by seed that bypasses the usual sexual process. This means it's not possible to make crosses or to

produce hybrids and have recombination of characteristics. The reason that we were interested in Dallisgrass was because of its bunch habit of growth, which permits it to grow with **Bermudagrass** and **White Clover** contrasted with species like **Bahiagrass** which essentially grows in monoculture. But, we now know it has better forage quality and nutritive value than bermudagrass and bahiagrass. (E.C. Holt, 1956. Dallisgrass. Texas Agricultural Experiment Station Bulletin 829. College Station.)

Let me take a parallel case which was more successful in a breakthrough and in giving full credit to our cooperation with USDA personnel. It involved **Buffelgrass** which was probably introduced in the late 1940's and became identified as a major grass in the early 1950's. The first work done on it was at the Soil Conservation Service (SCS) Nursery at San Antonio from seed that came from Africa. Primarily a South African species, it was actually of unknown origin. Buffelgrass was a good forage plant and adapted primarily to the Rio Grande plains area of Texas. Our basic program determined again that we were dealing with a species that reproduces by apomixis which results in no variation in plants produced by seed. So, there was no opportunity for improvement in the species. The best of the introductions were picked out and one called **T-4464** (a Soil Conservation Service number) was the one that was most widely used. It became known as **Common Buffelgrass**. We (Dr. Bashaw and I) were fortunate to have a plant called to our attention by a seed producer. Mr. Pat Higgins, from Sutherland Springs, had observed some segregation or variation among seedlings from a plant that he had increased from seed. He called this to our attention, and we picked up some of the parent plants and some seedling progeny. The cytology indicated that we had a sexual plant that reproduced by the normal sexual process. Through further experimentation, we found that we could use this as a female plant and pollinate it with pollen from an apomictic plant and produce F1 Hybrids, some of which would reproduce by apomixis, and these would then breed true. This means then that we can produce a true breeding F1 Hybrid that can be reproduced by seed, generation after generation, with no segregation. Not all F1's produce in this manner, as some reproduce sexually. This has to be determined either by cytology or by progeny tests.

The first use of apomixis in a breeding program and the first artificially developed obligate apomictic crop yield was '**Higgins' Buffelgrass** which was released by the Texas Agricultural Experiment Station in cooperation with the United States Department of Agriculture in 1967. Dr. Bashaw, a USDA plant geneticist, has been the leader in this, but it has been a cooperative program with TAES. You could say the discovery of sexual reproduction in Buffelgrass did make it possible to make hybrids and new combinations of characteristics that we need in order to improve the area of adaptation and other characteristics. The first one released was 'Higgins' Buffelgrass, a variety that has characteristics that Common Buffelgrass does not have which makes it a little more resistant to grazing. It spreads by rhizomes; whereas, Common (T-4454) Buffelgrass has no rhizomes. Rhizomes are actually underground stems that serve as carbohydrate storage organs and possess buds at the nodes capable of producing new stems. Our problem has been seed production. We debated among ourselves a good while as to whether these varieties would ever make any impact because of the seed problem. Now we think that they are so impressive that even if the seed industry doesn't grow them, the varieties will move from ranch to ranch, to some extent, because they are quite impressive compared with Common Buffelgrass.

More recently, apomictic breeding has been perfected with **Weeping Lovegrass**. **Guineagrass**, a tropical species found commonly in Central and South America and Texas, is also an apomictic grass. Research in Florida and Georgia, as a follow-up on the work here on Buffelgrass, has identified sexual plants and the manipulation of apomixis is being worked out.

Maybe I didn't adequately emphasize the fact that '**Coastal' Bermudagrass** is the most widely used, improved (Introduced) grass in the humid section of the state. Actually, it has extended further west than we ever expected it to. It is being used into the 25-inch rainfall area, and some is being planted even as low as the 20-inch rainfall area and probably in areas where some run-off water is received.

In fact, we do not recommend plowing up **Common Bermudagrass** and replacing it with Coastal Bermudagrass. But rather to manage the Common Bermudagrass to its advantage.

On the other hand, Coastal will produce from 20 percent to 50 percent more forage than Common depending on the production practices, the amount of fertilizer applied, and the water available. Coastal has made a major contribution to the cattle industry in the state. The quality after mid-summer is inadequate to provide a good rate of gain in young animals. I think we will hear more of it with the emphasis now on carrying animals to a heavier weight before they are put on feed.

Kleingrass, which is one of our better new grasses now being used, is an introduction from Africa. We have developed a variety, jointly with the Soil Conservation Service, called '**Kleingrass 75'**. Kleingrass is one of the most widely adapted Introduced grasses in use today, that is, in terms of area of adaptation. It's also of better nutritive value than most of the warm-season perennial grasses. The Texas Agricultural Experiment Station has had a major role in the development and use of Kleingrass which is now being used primarily from the Eastern side of the Blackland to the 15-inch rainfall zone west of San Angelo, and from the lower Rio Grande Valley north to about the mid-Panhandle area. Its major use is actually in the Rio Grande Plains, Edwards Plateau, Rolling Plains, and Blacklands.

This was a selection of the best plant material and the best introduction we had at the time. Our more recent efforts have been to improve seed production which is the main problem with Kleingrass. Kleingrass produces an adequate number of seed, but the seeds mature unevenly. They shatter or fall off about as rapidly as they mature. Our efforts have been to improve seed production and at the same time to further improve forage quality. We've made seed production selections, but they have not been released until we get these put together with improvement in forage quality. We are testing some of this material at the present time which will serve as a basis for decision on release that will be superior in seed production and nutritive quality or value. Another aspect that we are also looking at on this research is to increase seed size.

I would like to discuss **Rhodesgrass** briefly. It was evaluated extensively in Plant Introduction Nurseries between 1909 and 1918 at locations such as Beeville (Sub-Station No.1), Angleton, Balmerhea, Chillicothe, Denton (Sub-Station No. 6), Temple (Sub-Station

No. 5), and Tyler (Sub-Station No.2). It was found to be adapted only to the Rio Grande Plains area because of lack of winter hardiness further north. Rhodesgrass developed into an important forage grass in South Texas. Most of the fairly extensive plantings disappeared during the 1940's, and it was thought to be primarily due to an insect called Rhodesgrass Scale. A program was started to look for Rhodesgrass Scale resistance, and a variety was released in the early 1960's that was tolerant to Rhodesgrass Scale. This variety was named **'Bell' Rhodesgrass**.

The interest in legumes in Texas has been minimal. Because we have a tremendous grassland area, we have tremendous grass potential, and the cost of nitrogen has been minimal in previous years. For that reason, the research efforts have concentrated on grasses rather than legumes. This is not to say that we have done nothing at all about legumes. We've had, of course, fairly extensive work in the Gulf Coast (Southeast Texas) area with **Louisiana S-1 White Clover** and **Persian Clover** and work in East Texas with **Crimson Clover**, and more recently, with **Arrowleaf Clover**. I was about to say also the development of the **'Abon'** variety of **Persian Clover** in the Gulf Coast area, and the development and release of the late flowering annual **White Clover** called **'Israel'** which was used primarily for cover crop and for windbreaks.

We recognize as one of the most important areas in forage research, the matter of nutritive quality of the forage produced. Our research currently emphasizes that, and we would like to see this as continued with a greater emphasis, if that's possible, because of the change in the cattle production situation that we've already talked about. That is the necessity of carrying animals further on grass than we did in the past and the importance of efficient production. To do this, we've got to have a grass of good quality, of the best quality possible.

In terms of other grass development programs, there is a new program just being started at the Dallas Research Center that will work on **Tall Fescue**, which is a perennial, cool-season grass, and the emphasis will be on climatic adaptation since we are trying to adapt Tall Fescue to the Southern Plains area. But further than that, research emphasis also will be placed on nutritive quality of Tall Fescue. Tall Fescue is one of the most widely adaptative,

cool-season, perennial grasses in the United States and is very widely used. But it is also one of the poorest in quality of the perennial cool-season grasses.

In East Texas, one of the programs that is underway, and will be expanded, is on **Annual Ryegrass**. In this case, it is primarily to get a more rapidly developing seedling that will grow off faster from planting. Ryegrass is used for overseeding in sod for winter pastures. But the problem is that ryegrass develops slowly from seed so that there is a long period in the fall and winter, after the summer pasture stops, before the Ryegrass is ready. I want to back up and add to our discussion of quality improvement (from the breeding standpoint) that there is a plus factor here in that there is little or no cost input involved above that required for producing a lower quality variety of the same species, once you've established the grass of superior quality. You get greater animal gains on an equivalent amount of forage produced.

Now, an additional current and future direction in the overall program is the development of pasture systems for year-round cattle production or for cattle production systems in which weaned calves are kept on the farm for a longer period of time than in the past. Pasture research traditionally is done by individual experiments, measuring some treatment or some production practice rather than measuring the entire system.

I know in 1956, when we were trying to work out some of the problems that were being encountered at the East Texas Pasture Research Laboratory at Lufkin, Professor John K. Riggs (Professor, Department of Animal Science) and I worked together in setting up pasture grazing work there to try and solve some of the pasture production problems of East Texas. From that point in time, cooperation has continued in a very close working relationship by the two Departments on the Campus as well as the complete integration within the Research Centers where there are Animal Science and Forage or Agronomy people working together. Certainly no Departmental barriers are involved at the Centers.

Dr. Holt authored "Bermudagrass Production and Management in East Texas;"1968 with J.A. Lancaster, and "Wintergreen Cool Season Pasture Grasses," No. 893. 1958. with M. J. Morris, H. O. Hill, and H. E. Hutson. Another publication done with P. R. Johnson. E. C. Holt, P. R. Johnson, Mark Buckingham, H. C. Hutson, J. K. Crouch, and J. R. Wood. "Pasture, Hay

and Silage Crop for East Texas", Texas Agricultural Experiment Station Bulletin 893 (College Station: TAES, 1958.)

The Research and Extension Center at Overton is a good example. It is extremely important in forage-pasture research that Agronomists and Animal Scientists be able to work together. Certainly we have that favorable environment not only as it has developed between individual workers but fostered also by the department heads and the Experiment Station administration. J.M. Jones (Head, Division of Animal Science, TAES), starting back in the 1910's, did a lot of work on this. He was primarily responsible for getting that Sonora Station started. He worked at Beeville and started that program. In most cases, there was really no coordination with Agronomy. We now have what I consider one of the best working relationships between animal scientists and agronomists in the Texas Agricultural Experiment Station of any station that you could find. I don't think this has always been true. As we were just saying, some of the early grazing work such as that at Lufkin and Barnhart (Texas Range Station) and Beeville (TAES at Beeville; Sub-Station No. 1) was conducted primarily by Animal Science people with relatively little input from Agronomy.

I would attribute a considerable amount of the development of Agronomy-Animal Science cooperation to Mr. Marvin Riewe (Professor in Charge, TAES Station at Angleton) when, in 1956 and 1958, he spent a great deal of time working on his Master's Degree. In that era, he was starting controlled grazing experimentation at the Angleton Station, trying to get coordination between agronomy, animal science, and biochemistry. Marvin and I worked with **'Gulf' Rygrass** and **Tall Fescue-Dallisgrass** with grazing production and stocking rates.

In the 1950's, much of the graduate training was actually supported through research project funds. The assistantships were supported this way. More recently, funds have been earmarked at the Director's level for graduate assistantships. But the graduate program development in agriculture at Texas A&M has been influenced and supported, to a large degree, by the Texas Agricultural Experiment Station.

It would be easy enough for me to look up and actually list the number of students who have gotten advanced degrees in Forage Crops at Texas A&M. I would not be able to distinguish

TAES research assistant support from teaching support in those. At the end of 1975, there have been approximately 50 Master of Science and PhD degrees in Forage and Turf since 1948 under my direction."

Dr. E.C. Holt retired after 36 years of service and continued to serve Soil Crop Sciences Department as Emeritus Professor until his Final Retirement on September 7, 2015 at the age of 94.