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SOME FACTS ABOUT PLANT BREEDING, 1930-1970

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Overview

In 1930, Congress passed and the President signed into law the Plant Patent Act, granting patent rights to discoverers and creators of new varieties of non-sexually-reproducing plants. Tubers were excluded from the act, most likely because of their prominent role in the human and animal diets of America at the time. Sexually-propagated plants also were excluded from the act, on the grounds that they did not breed true and that there would be no way of producing an exact replica of the original, patented, plant. In 1970, Congress passed and the President signed the Plant Variety Protection Act (PVPA), giving patent-like protection to breeders of sexually-propagated plants with a few exceptions (the soup vegetables were excluded because of powerful lobbying on the part of the Campbell Soup Company). In the 40 years between these two legislative benchmarks several events intervened to convince legislators that plant production in America would be improved -- benefitting both consumers and crop producers -- if plant breeders had legal protection for their intellectual property rights.

The explanation for the particular timing of passage of the PVPA lies in a tangle of political, economic, and scientific developments of the 1950s and 1960s. The political and economic issues have been discussed elsewhere and Jack Kloppenburg has articulated the story of the commodification of the seed and the rise of the seed industry in his wonderful work, First the Seed: The Political Economy of Plant Biotechnology, 1492-2000.[1] In this paper, however, I would like to discuss the most basic dimension of the story: the developments in plant breeding that encouraged breeders to seek legal protection for their achievements. Rather than a complete history of plant breeding, this is a survey of some of the highlights between 1930 and 1970.

Botanists, employing conventional genetics, made remarkable gains during this period, especially when measured by total yield. "In the United States the average corn yield rose from 28 bushels per acre in 1940 to 78 in 1968. Sorghum yields jumped from 20 bushels per acre in 1954 to 60 in 1968."[2] And, when American breeders exported their techniques and technologies, they created the Green Revolution -- marked by drastic increases in yields in wheat in Mexico and rice in the Philippines. Although the Green Revolution's emphasis on yield and the consequent reliance on chemicals and fertilizers has been criticized harshly and justifiably in the last two decades, these were nevertheless the standards used by plant breeders, the seed industry, and consumers in judging their successes.

Some results were doubtless more encouraging than others to private breeders. For example, induced mutations, investigated from the early 1950s onward, provided little hope for a big financial return, with or without patent protection. On the other hand, some success in quicker breeding methods and in developing varieties resistant to different strains of plant diseases or suited to particular growing and harvesting technologies, might easily have held out hope to the private breeder of gaining a large payoff for entering the breeding arena, if patent protection was available. Finally, the failulre of breeders to achieve commercially successful F_1 hybrids for some of the major cereal crops undoubtedly made patent protection more desirable for private plant breeders.

Indeed, there was no single scientific discovery or particularly stunning breeding technique developed during this period that accounts for the precise timing of the re-interest in protection of sexually-propagated plants. There was, however, a steady improvement in crop yields and the continual introduction of new varieties adapted to different growing areas and resistant to different diseases. Together these form a contextual argument that indicates an atmosphere conducive to pressure for the PVPA.

Induced Mutations

In the hope of getting more useful genetic variation without waiting for nature, breeders have tried inducing mutations. E.G. Heyne and G.S. Smith, in 1967, said that

> As early as 1901, de Vries suggested the idea of inducing mutations in cultivated species. European workers began studies on this problem in the 1930's. However, it has been only since about 1946 that a concentrated effort has been made to use induced mutation as a plant breeding tool and its value cannot be accurately determined. However, it should be considered as another breeding procedure and, for most effective value, it should be used in conjunction with other methods.[3]

K.J. Frey and Ralph M. Caldwell, in their chapter on "Breeding and Pathologic Techniques" in <u>Oats and Oat Improvement</u> (1961), have discussed the development of interest in induced mutation:

> Considerable interest in the use of mutagenic agents to enhance plant breeding has developed since 1945. Few experiments with mutagenic agents have involved cultivated oats. Barley is the cereal most used in these studies. Gustafsson (1947) experimented with oats.

> X-rays are the most common mutagenic agent used to date. Gustaffson (1944) and Frey (1954) exposed oat seeds at 8 to 14% moisture content to a high dosage of X-rays usually ranging between 15,000 and 30,000 r units. These dosages usually kill from 50 to 95% of the seeds.[4]

Frey and Caldwell go on to discuss the use of thermal neutrons in mutation breeding experiments, done on oats by "Jensen et al. (1955), Konzak (1954, 1955), and Koo and Myers (1955),"[5] while Singleton (1955) "designed a so-called gamma field to allow the chronic radiation of growing plants either throughout the life cycle of the plant or for specific periods of the life cycle."[6] Beginning in 1951, a few investigators claimed that different mutagenic agents might be controlled to direct the mutation process, but Frey and Caldwell conclude that, in general,

> ... the evidence for directing the mutation process shows that it is somewhat effective for inducing chlorophyll mutations but seldom for inducing economically valuable mutations. Consequently, oat breeders are justified in being skeptical of claims of mutation channelization.[7]

Even undirected mutation offered small optimism, at best.

> A number of desirable mutations have been found in oats, but the predominant ones are undesirable. Gustaffson (1947) has estimated that in barley only 1 in 400 mutations is economically desirable. Thus extremely large radiation populations must be tested. Gustafsson (1947) and MacKey (1954) found mutations in oats that affect yield, maturity, straw stiffness, grain weight, and quality. Frey (1954, 1955) and Frey and Browning (1955) reported mutations for straw shortness, earliness, increased test weight, and stem rust and crown rust resistance. Mutations for rust resistance, earliness, and shortness of straw were reported by Konzak (1954). Jensen et al. (1955) found increased winter hardiness under New York condition, and Koo and Myers (1955) obtained stem and crown rust resistance in the Ajax and Clintafe varieties.[8]

John Poehlman's 1959 textbook, Breeding Field Crops, remained terse and non-committal about induced mutations: "How successful breeders will be in utilizing radiation induced mutations is not yet fully determined."[9]

Attempts to induce mutations continued, of course, and as late as 1967 Heyne and Smith maintained a generally positive outlook regarding induced mutants in wheat.

> The potential value of induced mutants for plant breeding purposes has been established. The Missouri Agricultural Experiment Station has recently (1964) released two varieties, 'Lewis' and 'Stadler,' which traced to irradiated material. Although there is still a large amount of natural variation in Triticum and related genera that has not been sampled, mutation breeding should not be discouraged. More research is needed to perfect the procedures of inducing and screening useful mutants. This research should be carried on by plant breeders in cooperation with plant geneticists and cytogeneticists.[10]

Still, the 1967 textbook Plant Science displayed little optimism in the discussion of induced mutations, mainly because present "mutagenic agents induce random changes, most of which are harmful, as are naturally occurring mutations. Since such changes are nondirectable and largely deleterious, the problem is one of detection and isolation of the rare desirable alteration."[11] The text went on to note a few useful mutations in barley "and higher-yielding strains of the mold Penicillium (for penicillin production) by ultraviolet irradiation," but remained pessimistic overall:

> In general, however, progress with induced mutations has not been proportional to the effort expended. Because of the unpredictability of mutation breeding in a practical improvement program, it can be considered only as a last resort after other sources of variation have been exploited and found wanting.[12]

Overall, it is hard to imagine that induced mutations, random and difficult to isolate as they were, would have offered enough optimism to serve as an impetus for the PVPA. As Frey and Caldwell warn, "[b]oth desirable and undesirable mutations may occur in the same strain."[13]

CMS and the Hybrid Promise

Reliance on F_1 hybrids for commercial crops provides perfect intellectual property rights protection for plant breeders. If the F_1 generation has the commercial qualities farmers want, then breeders grow the two parent lines, cross them, and sell the resulting seed to farmers. Farmers grow the F_1 generation crop, but they cannot use the seed they might then harvest for future plantings, since it will not produce a crop of the desired quality. Seed must be purchased for each planting and the breeder's intellectual property rights are completely protected without need of any laws.

Commercial hybrid corn seed was available for sale to farmers in 1926.

> Hybrid corn was planted on about 1 percent of the corn acreage in the Corn Belt in 1933 and on almost 100 percent in 1955. The wide adoption of high-yielding hybrid strains in 1938-1945 led to an increase of 15 to 20 percent in the average yield of corn in the United States.[14]

The success with corn caused an on-going search for hybrids in other plants. Successful commercial hybrids were introduced for the onion in 1944, the sugar beet in 1945, and sorghum in 1955. Pearl millet was on its way by 1969. Other crops -- including major cash crops like wheat and barley -- did not lend themselves quite so easily to hybridization, largely because they are self-pollinating.

In order to get plants to cross-pollinate breeders relied on emasculating them by hand. This was time-consuming, costly, and consequently did not lend itself to commercial farming. The discovery of a male-sterile plant of the Italian Red onion by H.A. Jones in 1925, and the suggestion of a feasible method for using it to develop hybrids by Jones and Emsweller in 1937, created a wave of optimism about hybrids that has not broken yet.

> Male sterility is necessary for the controlled cross pollination of plants. It is, however, essential that the male fertility be completely restored in the F_1 hybrid even under conditions adverse to male fertility, to ensure the maximum yield of the F_1 hybrid.[15]

Male sterility could be induced through chemicals, but by 1969 this still was not reliable enough for producing food crops.

> At present [1969], the most efficient way to eliminate selfing is to make use of the genetically determined male sterility that results from the interaction between a cytoplasmic factor and nuclear genes. The cytoplasmic factor is transmitted only through the pistillate parent. ... This male sterility results from the interaction of the cytoplasmic factor with one or more recessive genes. In the dominant condition these genes are known as "restorers" of fertility. Cytoplasmic male sterility can be incorporated into inbreds by backcrossing.[16]

Once the plant is male-sterile it can no longer fertilize itself and must be cross-pollinated.

Cytoplasmic male sterility (CMS) was described for onion in 1944 by Jones and David, and for corn by Jones and Mangelsdorf in 1951. Corn was already enjoying great success as a hybrid by this time through the employment of hand emasculation (relatively easy in corn -- workers remove the tassels without damaging the corn; not so easy in other species where the anthers are inside the plant, near the flower), and CMS just made the process cheaper.

The discovery of cytoplasmic male sterility in wheat plants by Kihara in 1951 and Fukasawa in 1953 gave hope to wheat breeders. But the resulting hybrids were slow to mature and generally undesirable, largely because the varieties used as research stock were not commercially desirable in the first place. Researchers worked with whatever variety of wheat demonstrated CMS, and could not confine their work to varieties that had already demonstrated success in the marketplace.

Wheat breeders had no further luck with CMS hybrids (or any other kind, for that matter) for several years. Hybrids kept ending up sterile, as announced by Fukasawa in 1953 and 1959, but the research continued. In 1961, J.A. Wilson and W.M. Ross reported some success, when "[t]he sterility in Triticum with A. ovata cytoplasm developed by Fukasawa was transferred to hexaploid hard red winter wheat." Although this was good news, it was hardly cause for celebration since "[t]his material was not practically useful because the A. ovata cytoplasm had effects other than male-sterility, especially at maturity."[17] Then, in 1962, Wilson and Ross announced the discovery of a source of cytoplasmic sterility and male-fertility restoration. Breeders were very optimistic until the end of the 1960s, although they understood the full depth of the problems involved.

In No. 13 of the Agronomy series of the American Society of Agronomy, Wheat and Wheat Improvement (1967), the language regarding wheat hybridization remained optimistic. Heyne and Smith assert that "[t]he basic genetic mechanisms for producing F_1 hybrid seed in wheat are available. The economic production of commercial F_1 seed remains to be worked out."[18]

For people with their basic genetic mechanisms easily available they certainly list some serious problems. Among the hurdles faced by hybrid wheat were the following:

> 3. The range of heterosis is comparable to that in corn, but these studies have been from space-planted material not entirely comparable to present commercial seeding practices.
> 4. Wheat is a self-fertilized species and hybried seed set under natural conditions has been variable but generally low (range 5 to 70%). For higher seed sets, strains should be developed that shed more pollen, extrude the anthers, have a larger

> stigmatic area, and have flowers that will stay open longer. Planting schemes for seed production (ratio of male to female, rows or drill strips) must be developed.
> 5. Rate of seeding is high in relation to crops such as corn and sorghum and seed costs need to be determined in relation to increased yields.
> 6. ...
> 7. A number of hybrids will be needed since they will be specifically adapted to certain areas and uses just as the present varieties are.[19]

In other words, the limited positive results achieved by breeders were not commercially reproducible. They still were not by 1980, although some seed had been released with great hopes in the late 1970s.

Borlaug and the Nobelity of Wheat

Although the chimera of wheat and rice hybridization to match corn's successes did not materialize by the time PVPA was enacted, they were, by the late 60s, nevertheless touted as miracle crops, with a potential for transforming agriculture and ending world hunger. While wheat and rice production enjoyed healthy increases throughout the West from 1940 on, Mexican wheat stands out as the most noteworthy (and most noted) achievement before 1970.

> Maximum wheat yields now have been pushed above the 200 bushel per acre mark in the United States. Average wheat yields in Mexico rose from approximately 11 bushels per acre in 1945 to 41 bushels per acre in 1967. Mexico has been self-sufficient in wheat production since 1956.[20]

In 1970, Norman Ernest Borlaug (born in Iowa in 1914) received the Nobel Peace Prize for his contributions to Mexico's transformation.

Borlaug began working in Mexico in 1944 as a research scientist in charge of wheat improvement for the cooperative agricultural program of the Mexican Minsitry of Agriculture and the Rockefeller Foundation. Borlaug's goal was to develop a dwarf wheat that would survive and yield well throughout Mexico's varied growing environment.

> He amassed germ plasm from Japan, the United States, Australia and Colombia, and then began growing two alternate crops of wheat each year at two different

sites, a summer crop just south of the United States border and another crop in winter near Mexico City, some 800 miles away. The two sites differed in day length, or photo-period, as well as in many other environmental factors. The combination of the cosmopolitan ancestry of his seeds and the two varying sites enabled Borlaug to produce a dwarf wheat variety that was remarkably adapted to a wide range of growing conditions. The Mexican dwarf wheats today [1970] are growing successfully throughout the broad latitudinal range from Turkey to Paraguay.[21]

The wheat Borlaug developed was both widely adapted and high-yielding (but was not necessarily a pure line -- in 1953 he advocated the development of a compositive variety that would include genes from many disease-resistant wheats). He overcame the problem of lodging that usually ruined crops when they were heavily fertilized (the grain gets too heavy for its straw and falls over). Borlaug's dwarf wheats were short with stiff straw and responded well to heavy fertilization.

In 1960, Borlaug, by then associate director of the Rockefeller Foundation's Inter-Am Food Crop Program, initiated an international nursery in spring wheat, which "was instrumental in early identification of the varieties that are now [1970] revolutionizing wheat production in India and Pakistan."[22]

In 1965, Pakistan bought 350 tons more imports of Mexican dwarf wheat for seed. These 350 tons planted 12,000 acres where they yielded a 50-fold increase, four times the normal Pakistani yield. From the increase, 300,000 acres were planted, included 35,000 one-acre demonstration plots in 18,000 villages. In 1967, Pakistan imported 42,000 additional tons of Mexican dwarf wheats.[23]

And, in 1970, Borlaug received the Nobel prize.

According to Jack Doyle, deputy attorney general Richard Kleindienst, while not opposed to the PVPA in 1970, did raise the issue of whether or not important food crops should be in the control of private industry.

"Furthermore," wrote Kleindienst, "we have no indications that [the] development of new varieties of sexually reproduced plants in this country has been retarded by the lack of private protection. It would seem that the contrary is true," he continued, "[as] evidenced in part by the award of the Nobel Peace Prize on December 1, 1970, to Dr. Norman E. Borlaug of this country for his research into and development of new grains. Dr. Borlaug's technological breakthrough is now in the public domain, but could have received patent protection for seventeen years under S.3070."[24]

While Kleindienst may have taken the moral high road on this issue, there is no reason to think that private breeders had not learned an equally striking lesson from Borlaug's success. That Borlaug had introduced new varieties of wheat that were being used around the world could hardly have escaped their attention. That such success could be lucrative in private, patent-protected hands, was obvious.

Speed Breeding

To obtain a homogeneous new variety, whether for hybrid use or pure line release, takes a great deal of time. Breeders try to speed up the process by shortening the time for each generation's development. Heyne and Smith describe a few techniques for speeding up wheat research.

> In early generations, when seed quantities are limited, the greenhouse or growth chamber offers a convenient means of growing extra generations. Many wheats require a brief period of dormancy after ripening (2 weeks is common). Spring wheats will complete a life cycle in 4 months and winter wheats can be accelerated by vernalization. By special techniques, wheat seed (e.g., of new crosses) may be induced to germinate 2 weeks before maturity and the next generation initiated, if the effort is justified. Thus, with light and temperature controlled, three generations of spring wheat are grown routinely in 12 months. Some workers reportedly have grown four generations a year (probably with some sacrifice in seed quality).[25]

They offer two specific cases in which time was shortened for release of new varieties.

> Fourteen generations were grown in 7 years between the last cross and farm release in the production of Justin [1962]. More rapid increase was accomplished with durum wheat during the 15B stem rust emergency. Two thousand bushels

> were released to farmers less than 5 years after the last cross was made and 10 generations were utilized in selection, testing, and increase.[26]

The USDA also tells of their hope for a quick response to five new rust races that afflicted oats in the United States in the second half of the 1950s. They started an emergency program to develop resistant strains in the winter of 1957-58 and came up with eleven strains that were resistant to the most virulent of the new rusts (Race 264). The 1958 Report of the Secretary of Agriculture predicted success.

> Development of new varieties from these resistant strains through conventional methods could take, normally, about 10 years. However, by speedup methods of backcrossing, resistant varieties suitable for commercial production could be ready for growers in about 6 years or less.[27]

Shortening the development time for reliable new varieties obviously enhances the situation for breeders and could turn a private breeder's mind to thoughts of variety production and protection.

An Infinite Variety

If hybrids were not successful in all species during this period, the steady introduction of new varieties, particularly on the part of the USDA and SAES, made it apparent how many different plants could and would be used even without hybrids. New disease-and pest-resistant varieties were introduced nearly every year. In wheat alone, progress was made in "resistance to hessian fly, green bug, and other insects; a greater winter hardiness; stiff straw; and a higher resistance to smuts and rusts."[28] The fact that new varieties of disease continued to turn up offered private breeders hope of a continual demand for new varieties, while the on-going success in finding resistant varieties to the new diseases meant the continual supply of product to meet the demand.

Part of the developments simply occurred because of large-scale research and increasing availability of international plant collections. The efforts to find resistant varieties to new rust races attacking oats -- mentioned in the speed breeding section above -- serve as a good example.

> Seeds of more than 4,800 different oats were assembled for use in the program. First tests were directed at finding resistance to the most virulent of the new rusts -- Race 264. Eleven resistant oat strains were found through the emergency program.[29]

Similarly, "[t]he ARS-Nebraska research team is screening the USDA World Collection of wheats. Since 1967 we have measured the protein and lysine content of 15,000 strains."[30] The impressive development here is not a breeding technique but the presence of such a large base from which to launch a breeding program.

Breeders in the 1930s began to move away from selection alone as a breeding method. A variety of crossing, backcrossing (used in the great oat ruse fight mentioned above), hybridization, and recurrent selection techniques were employed to create varieties. Soybeans, for example, do not lend themselves to hybridization, but hybridization and backcrossing, combined with selection, became very effective techniques for improving them. Soybeans became very popular in the 1920s as an oilseed crop, and there was a demand for high-oil, yellow-seeded varieties.

> Some of the leading varieties in 1929 were Illini, Dunfield, Mukden, and Scioto, which were direct introductions from the Orient or selections from such introductions.
>
> It became apparent that various combinations of the desired attributes could not be obtained readily by a direct selection. Between 1930 and 1940, hybridization (followed by selection) or hybridization and backcrossing (followed by selection) became the standard breeding procedures.
>
> Most of the varieties released since 1940 were developed following controlled hybridization.[31]

These techniques, employed heavily in all areas of breeding, were showing remarkable payoffs by the late 1960s.

> The dwarf wheat "Gaines," developed at Washington State University, in the period 1949 to 1961 by O.A. Vogel, and "Nugaines," another derivative of the cross of Norin 10 by Brevor, were used to plant about two and a half million acres of the wheat acreage of the Pacific Northwest in the 1967 and 1968 seasons. Many yields in the range of 150 bushels per acre were recorded. One farmer obtained a yield of 209 bushels per acre, the world record for wheat (the U.S. average was about 26

bushels per acre).[32]

Norin 10 was a Japanese variety of dwarf wheat. Borlaug used Japanese strains to cross with Mexican strains to create his Mexican dwarf variety.

Selection and crossing techniques were further enhanced by the development of ways to manipulate and exploit polyploidy. In 1937, A.F. Blakeslee and A.G. Avery announced the use of Colchicine, an alkaloid developed from the autumn crocus, to double the chromosome number in some plants. "This drug interferes with spindle formation in mitosis; the chromosomes divide, but the cell does not. Tetraploids are produced routinely with the use of colchicine in many plants."[33] It is used to treat seeds, or is applied to the growing points of seedlings or other vegetative parts. The resulting autotetraploid (the increase is caused by doubling the chromosomes of a single species -- as opposed to allopolyploids where the doubling is preceded by hybridization between two different species) is usually distinguishable by larger, thicker leaves and organs, and slower growth, as well as reduced fertility.

Triticale is a product of polyploidy research. It is an allopolyploid from a cross of wheat and rye -- the goal is to combine the quality of wheat with the hardness of rye. Available as early as 1947 (it's discussed in the Sears article in the 1943-1947 Yearbook of Agriculture), Triticale did not begin to pay off until the late 1960s. It was introduced in 1967 as a new cereal and was hailed as a marvel, having had its infertility problems selected out of it in the intervening 20 years.

Another development of the 1930-1970 period that has aided breeding is work with monosomics (plants with one chromosome less than normal) and nullisomics (plants with one chromosome pair less than normal). The basic information in this section comes from Poehlman's chapter on wheat breeding in his 1959 Breeding Field Crops.[34] Because wheat is polyploid (as are many of the common crop plants, including oats, tobacco, and cotton) inheritance studies were slow in finding links of character to gene. Work with monosomics and nullisomics, beginning in the 1940s, sped up the process because fewer crosses are needed to identify gene-chromosome linkage.

> A program for the use of nullisomics in cataloguing the genetic factors for disease resistance in wheat has been in progress since 1942 at the Missouri agriculture Experiment Station and at Beltsville. In this program, in which H.A. Rodenhiser and I [E.R. Sears] are collaborating, resistance to the widely destructive disease, black stem rust, has received most attention. The objective of the study is to find the major genes for rust resistance in wheat, and to learn on which

> chromosome each of these genes is located. The information obtained should enable breeders to put together new varieties with superior resistance to disease and to improve the resistance of existing varieties. In the building up of these new varieties the nullisomics and monosomics will again be useful, since they may be used to increase the ease and precision of transferring chromosomes and genes from one variety to another.[35]

The program met with success and "Genes conditioning stem rust resistance [E.R. Sears and H.A. Rodenhiser, 1948], leaf rust resistance [E.G. Heyne and R.W. Livers, 1953], solid stems [R.I. Larson, 1952], and other characters have been located by this procedure."[36]

Plants to Match Machines

The first story of successful matching of plant with machine is that of the tomato. This is just a brief nod to Hard Tomatoes, Hard Times[37], but it offers a convincing contextual argument for private breeders' interests in PVPA. The first crop to be bred specifically for suitability to machine harvest was tomatoes. However, by 1968, breeders were demonstrating success in suiting lettuce and spinach to machine harvesting, and were hard at work redesigning beans and lima beans.[38]

In 1947, G.C. Hanna at UC Davis started working on developing a tomato variety able to hold up to machine harvesting and bulk handling. His goal was to create a pliable fruit in a variety with small-vine stature and a shortened ripening period. A few years later C. Lorenzen began work on a tomato harvester.

> By 1959, Hanna had developed for simulated harvest by machine numerous strains sufficiently uniform in vine type, concentrated profuse fruit set, maturity, resiliency of fruit, quality characteristics, and ability to "hold" for 30 days or more on the vine without deterioration. A large number of these were harvested by the prototype mechanical harvester in 1960.[39]

Trials were again conducted in 1961 and two varieties (VF 145A and VF 145B) were released to seedsmen and growers. "By 1962, both the machine and the plant were ready to go." "Strains of the VF 145 group and the variety with elongated fruit, VF 13L, released in 1963, comprise almost

90 percent of the acreage planted to tomatoes in California in 1967."[40]

That the breeder's mindset might be influenced by such an example of success in matching new varieties to new machines is indicated in Webb and Bruce's observation that "Machines are not made to harvest crops' in reality, crops must be designed to be harvested by machines."[41] Must had been complemented by could, and the political pressure for protection of plant breeder's rights increased.

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