

ARTICLE

Breeders' work after cultivar development - the stage of recommendation

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Abstract – *The development of new cultivars is the ultimate goal of breeding programs and is the result of many years of hard work and dedication of breeders and their teams. An important part of the process, often neglected by geneticists, is the stage from recommendation to the production of breeder seed (post-breeding). This paper discusses the role of the breeder in the recommendation, registration, protection and marketing of new cultivars. The breeder's active participation in all phases of post-breeding is fundamental to ensure that the cultivar reaches farmers quickly and can provide the benefits expected by society.*

Key words: *Varieties, marketing, advertisement, breeder seed, post-breeding.*

INTRODUCTION

Plant varieties or cultivars represent the end products of plant breeding programs. "Cultivar" can be defined as a homogeneous and stable group of individuals of any plant species whose characteristics are clearly distinguishable from other cultivars (Brasil 2007). The type of cultivar used to propagate a crop is directly influenced by the species' reproduction mode. The main types of cultivars used to propagate the commercially cultivated plant species that provide much of the energy and protein required for human survival consist of clones, inbred lines and hybrids.

The development of new cultivars with characteristics superior to those already on the market is the main objective of breeding programs. In general, a set of essential prerequisites must be met for the commercial release of a new cultivar, such as high yield potential and stability, final product quality, agronomic adaptation and reproducibility, disease resistance, abiotic stress tolerance (to drought, heat, cold, salinity, flooding, heavy metals in the soil, etc.), adequacy to the farmers' technology level, adequacy to the demand and requirements of agricultural industry and benefits for the final consumer with regard to aspects of nutritional and functional food value and food security.

To establish a combination of all these essential features in a single plant or cultivar is a complex process and represents a major challenge for breeders. To unite as many genes or favorable alleles as possible in a single cultivar requires a large number of generations of selection and testing of the best plants, and a large amount of material, human and financial resources. The purpose of this paper is to discuss the work of breeders after the development of cultivars and describe the main steps involved in the recommendation, registration, protection, and commercial release of new cultivars.

Importance of the recommendation step

The development of a new cultivar requires many years of hard work and dedication of the breeder and his team. This endeavor will only be rewarded if farmers get the new cultivar quickly and if they adopt it promptly and successfully in their agricultural enterprise. Between the identification of a line with the potential for commercial release as new cultivars and its use by producers, two essential steps should be considered: 1) the decision, based on experimental data, in terms of the merit of the new line to be released as a cultivar and 2) seed propagation (Simmonds 1979). However, many breeders, especially in the public sector, seem little interested in the stage of post-breeding, which involves

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several years of testing in different environments consisting of different locations, while concurrently multiplying seeds to obtain sufficient quantities to ensure an impact of the new cultivar on the market, when registered and protected by the MAPA/RNC (Ministry of Agriculture, Livestock and Supply/National Service of Register and Protection of Plant Varieties (Law 10711 of August 05 2003 and Decree 5153 of July 23, 2004) and legally made available for farmers and seed producers (Brasil 2007).

Cultivar recommendation in Brazil

The recommendation system of cultivars in Brazil was initiated in the late 1960s and early 1970s, when public and/or private breeding institutions founded regional crop-specific commissions. The South Brazilian Commission of Wheat and Soybean was created, among others. These committees organized experimental networks and established rules for the release of new cultivars, such as the number of locations and years a line should be tested in, the cultivars indicated as controls and specific criteria to determine the commercial release of new lines, i.e., a yield level based on the control cultivars, and other attributes such as wide adaptation and product quality. The experimental networks formed a cooperative system of test trials of the new lines, involving public and private companies, which performed the tests without any remuneration for the service. This cooperative system consisted of institutions/companies interested in research, extension or trade of a particular crop. Consequently, not only the institutions/companies involved in the breeding of the crop participated in the cooperative system. At annual meetings, the results of the regional test trials were presented and discussed. The release or disposal of experimental lines was determined on a collegiate basis, where each participating institution was entitled to one vote. In the end, based on data obtained in experiments carried out by the different institutions and when the previously established criteria had been met, the system issued an approval for the commercial release and the cultivar was included in the list of those officially recommended.

The official regulatory system of cultivar recommendations began with the former Seed Law (Decree No. 81,771, of June 7, 1978), where Article 29 stated: "only those agricultural species, cultivars or hybrids are eligible for the production system of controlled seed, which are approved by the supervisory body, based on research recommendations, and which meet the interests of national agriculture." These principles led to the publication of Ordinance No. 178 of July 21, 1981, which established the Brazilian System of Cultivar Assessment and Recommendations and Ordinance No. 271, October 6, 1982, which instituted the Brazilian System of Cultivar registration. These systems were coordinated by the

official research trough of the Brazilian Agricultural Research Corporation (Embrapa). The evaluations were conducted in the form of a cooperative agreement with the other public and private research companies. The implementation of the evaluation and recommendation came under the control of regional commissions, organized according to the products, which were in charge of defining the experiment and data collection, recommendation lists and application for approval of the MAPA. The registration of cultivars was also under the auspice of Embrapa, internally delegated to Embrapa Recursos Genéticos e Biotecnologia (CENARGEN), which registered basically all cultivars obtained by public research, except for a few developed by private companies (Costa 2007).

To get financing or an insurance (Agricultural Activity Insurance Program - Proagro) of the crop production, farmers were obliged to use a cultivar that was in the list of officially recommended varieties. The public and private banks would fund the production, provided that the planted cultivar was listed among the officially recommended.

Cultivar registration and protection

With the new Brazilian regulatory framework implemented in 1997, the National Register of Cultivars (RNC) and the National Service of Plant Variety Protection (SNPC) were created. Ordinance No. 527, of December 30, 1997, established the RNC, under Law No. 10.711, of Aug. 05, 2003 and regulated by Decree No. 5,153, of July 23, 2004. The RNC had the following objectives: i) to replace the old system of cultivar evaluation, recommendation and registration of new plant varieties (ordinance No. 178 and No. 271) through the implementation of an information database provided by the breeder or owner of the rights to exploit a cultivar, who were assigned responsibility for the evaluation and recommendation of the cultivar for agricultural cultivation, ii) to initiate the registration of new domestic and foreign cultivars, licensing production, marketing and use in the country, iii) to set up an information index of the value for cultivation and use of new cultivars and their characteristics, and iv) to provide an updated list of registered national cultivars of the species and cultivars available on the market over Internet (<http://www.agricultura.gov.br/vegetal/registros-autorizacoes/registro/registro-nacional-cultivares>).

This register or CNCR (National Index of Registered Cultivars) is unique and should contain the cultivars accredited by RNC and their holders (Costa 2007). Currently, the RNC licenses cultivars for nationwide production and processing and for seed sale. For the registration of a particular cultivar by RNC, it must first be subjected to tests that determine the value for cultivation and use (VCU), i.e., the intrinsic

value of the combination of agronomic characteristics of a cultivar with its suitability for agricultural, industrial, and commercial use and for fresh consumption (Carvalho et al. 2007). Thus, only the cultivars accredited by RNC can be officially propagated and sold in Brazil.

The same regulatory framework of 1997 included a law of cultivar protection (No. 9.456/97), coordinated by MAPA through the SNPC. The SNPC protects new cultivars that are different from the existing (different in morphological traits), homogeneous (show no variation) and stable in their genetic and phenotypic characteristics over several years of cultivation and are new. In this context "new" is not related to the inventive activity, but to the time on the market. To be considered "new", cultivars of any kind may not have been for sale for over 12 months in Brazil. However, the primary attribute making a cultivar worthy of protection is that it is the outcome of a plant breeding process (Aviani 2011).

The protection of intellectual and commercial property rights of a cultivar is given by the issuance of a certificate of plant variety protection. This certificate is considered a property good and is the only form of protection of plant species in Brazil (Aviani 2011). The protection aims to warrant the reproduction rights of the new genotype of the holding institution, so that a license of the holder is required for the registration of any field of seed production by MAPA. This cultivar protection allows the holding institution to prevent others from producing seeds without legal authorization. Due to the requirement of the license, the seed producer has to apply annually for an authorization by the holder to have the area of protected plant variety registered. This approval may be related to the payment of royalties to the holder for using the cultivar. The contracts and values vary widely among institutions and these royalties are already included in the market seed price. This system of cultivar protection can also be used by institutions as a form of managing and evaluating the efficiency of breeding programs, since the authorization of fields and the control of their production, per county and seed category, and the use and adoption of this new technology – cultivar can be mapped.

Opportunities and difficulties with the new regulatory framework

The new law of protection of intellectual property rights induced a major shift in focus, as the official recommendation was disused and information from the new cultivar comes from data of the Institution releasing it. The Brazilian state, through the MAPA, has a normative role and oversight of the Brazilian seeds while the cultivar holder is responsible for the field trials, the reliability of the information and applications for registration and protection by MAPA. The cost or profit of

these claims is at the expense of the holder, before the Brazilian legislation of seeds and consumer rights (farmer and seed producer). For the registration of a new cultivar its usefulness must be evidenced, in tests of value for cultivation and use (VCU), which are carried out according to the standards for each species as determined by MAPA-RNC, and should cover the regions for which the cultivar will be recommended. The choice of where the tests are conducted is highly relevant to assist in the selection of new cultivars with better characteristics than those already commercially available.

The purpose of the VCU trial is to evaluate the potential performance of a line for one or more important traits. For the major crops, this characteristic is grain yield, compared with known cultivars (checks) in a given region. Particularly in the sub-tropical conditions of Brazil, VCU trials are tailored to evaluate the performance of a new line in the varied environmental and technological conditions farmers face in the major producing regions. The sub-tropical and tropical environments of Brazil are characterized by large variations in soil type and quality, as well as in monthly precipitation, temperature, etc. (Paterniani 2000.) Also, there are great differences of the level of technology used by farmers.

The locations of the VCU trials can be selected for convenience or for the diversity of the agricultural region. Thus, if locations are chosen that adequately represent the variability of possible environments of the new cultivar, this can avoid the commercial release of cultivars with low adaptation to the variations commonly observed in the field. The inclusion of experimental stations already established in the major cultivation environments can be a strategy to reduce costs and obtain the necessary information. Another strategy by some companies is to use fields of leading farmers for the VCU trials in regions where the crop plays a major role. The greatest difficulty until recently was the quality of these experiments, frequently unsatisfactory when carried out on areas outside the experimental stations. However, with the quality of the planting and harvesting machines of today, this problem is largely overcome.

For the major crops, the MAPA-RNC should be formally informed about the locations of VCU trials. All data used for registration are obtained and are the responsibility of the proposing institution, without any third-party role, which somewhat diminishes the data reliability. For some crops, the informal system of release of new cultivars in a collegiate system is still in use, following the rules of research committees, as in the past. In this system, the breeding programs of the species participate voluntarily. The advantages of the system are: 1) an increase in number and range of test environments, 2) reduction in the cost of VCU testing, because each institution is responsible for tests at only one or few locations; 3) control cultivars are defined previously (usually the best

in cultivation), 4) the rules for inclusion or continuity of test lines as well as the release of new cultivars are discussed and decided by all members of the committee, 5) the opportunity for breeding programs to evaluate and compare their best lines with other lines from different breeding programs, 6) to have discussions on important issues of the crop and orientation for collaborative actions of research between different institutions. The continuation of the institutions in the cooperative system constitutes the unrestricted acceptance of decisions made by the research commission. On the other hand, this system also has disadvantages, for example: a) the lack of control of how the trials are performed by the participating institutions and the quality of experimental data, b) the new lines will be available to third parties, c) the decision of releasing a new cultivar is taken on a collegiate basis (all participants decide) and therefore depends not only on the holding institution. In this system, although the decision-making is collegial, the process of registration and protection by MAPA, the market advantages and possible penalties by law due to technical problems will concern only the holder.

According to the Brazilian law (No. 10,711), the registration of new cultivars depends on the VCU trials, while their protection depends on the performance of trials of distinctness, uniformity and stability (DUS) (Law No. 9456). Currently, specific rules for VCU trails have been established for 17 species, while general standards are used for the other species, defined by MAPA-RNC, in Annex 9 (<http://www.agricultura.gov.br/vegetal/registros-autorizacoes/registro/registro-nacional-cultivares>). As described earlier, the performance of the VCU trials and data reporting to MAPA-RNC is the responsibility of the holders and can be performed independently by the breeding institutions/companies or in cooperative systems, with their intrinsic advantages and disadvantages.

Oats is an example species for the cooperative system of evaluation of cultivars and breeding lines, initiated in 1979, and continued to the present day, in compliance with the standards of the Brazilian Committee for Oat Research (CBPA). According to the commission, a new line is tested for four years before being released commercially as cultivar. Each year the lines are compared with three checks cultivars, previously chosen by the CBPA, representing the cultivars with highest yield potential and/or greatest commercial importance. The first year consists of the preliminary test, usually at a single location, at the headquarters of the breeding program. Lines that reach yields equal to or more than 5% better than the best check can be advanced in the following step. This step consists of the Regional Line Test, which lasts one year, at 8 - 10 locations. Again, the lines which, averaged across all locations, have yields equal to or over 5% superior to the best check, can be advanced to the Brazilian Line Test. This test represents the final test stage and lasts two years, at 9 - 12

locations per year. For a commercial release, the line has to perform better than the best check in a three-year average and in the mean of the all test locations by at least 5% or alternatively present some peculiar characteristics, such as disease resistance or better grain quality, provided that the yield is similar to that of the best check. The holding institutions propose the release of such superior lines as new cultivars to the CBPA, which in a collegial decision, will vote for or against the approval. The interference of the institutions that make up the CBPA in the release of new cultivars can help identify the cultivars that are actually superior.

This partnership greatly reduces the cost of conducting VCU trials for breeding programs, since each research institution is responsible for conducting them at one or a few sites. Once the application for the commercial release of a new cultivar was approved, the breeding programs have the right to use the results obtained by the partner institutions for the registration of the new cultivar by MAPA-RNC.

For crops planted on vast territories, such as corn and soybean, the companies have to conduct a large number of experiments in all producing regions of Brazil (from 50 to over 100 locations per year). With the currently available statistical techniques, it is possible to use fewer locations, which represent all producing regions. In this way, a large number of lines are tested at these sites and only those with superior performance are subsequently tested in the other environments. Examples with common bean in the state of São Paulo are described by Carbonell and Pompeu (1997), with soybean in Paraná by Mendonça et al. (2007), soybean in Central Brazil by Pacheco et al. (2009) and with corn in seven Brazilian states by Oliveira et al. (2010).

In some countries, mainly in Europe, VCU trials are conducted by official institutions, at different locations and for several years. According to the results, the line is released or not. In the current Brazilian system, the lines can be compared with any cultivar that is registered in MAPA-RNC. Some institutions, both public and private, have used large numbers of cultivars listed in the RNC as checks in the VCU trials. In the end, they chose as a check the cultivar with the most favorable data in comparison with the experimental lines been tested. This approach prevents a direct comparison of contemporary lines of the different programs, because different cultivars are used as checks. This line of action has led to the commercial release of cultivars with characteristics inferior to those already on the market.

It is up to the breeder to watch over the registration of cultivars that add competitive advantages, especially for the less-known species with less space in the seed market. Only cultivars with a good agronomic performance, superior to those on the market, ensure an excellent yield of the final product, profit and maintenance of the farmers in their business.

Until recently, most cultivars were approved based on a direct comparison with standard cultivars, with a limited use of statistical tests. But with the advancement of statistical models and computational facilities, statistical analyses are being used increasingly to estimate the genotypic value, independently of the environments tested. The advance in the analysis of genotype- environment interaction and the identification of adapted and stable genotypes is enormous. However, the application to direct recommendations of cultivars is still limited, probably because the lines are not the same in all test years, the number of lines being tested is limited, the precision in the determination of environmental indices is low and the correlation of the performance of lines with the environmental index is high. New methods, such as the Best Linear Unbiased Prediction (BLUP), are useful in the analysis of VCU trials data in view of their accuracy and precision, especially for the annual elimination of inferior lines and particularly in non-orthogonal data analysis (Borges et al. 2012). Originally, BLUP was used in animal breeding and has only recently been exploited in plant breeding programs (Souza Jr. 2011).

The new regulatory framework for the registration and protection of plant varieties created two different and complementary mechanisms: the registration and the protection of plant varieties. For official seed production, a registration of the cultivar by MAPA-RNC is required, while to get financial benefits (royalties), the cultivar must be protected by MAPA-SNPC. For the protection of new cultivars DUS (Distinctness, Uniformity and Stability) trials are mandatory. Under Brazilian conditions, DUS trials should be performed in at least two consecutive years and at one location, by the institution that will protect the line. This trial is intended to determine whether the new cultivar is distinguishable from other cultivars, based on previously determined morphological traits of the species, and if the new variety is sufficiently uniform and stable, to meet the requirements of the law of seed certification.

The main DUS trials should be performed by a breeder itself or by a person with previous experience or specially trained for the correct identification of descriptors, since this test determines the legal identity of the new cultivar (comparable to an identity card or passport). If a cultivar can be distinguished from others based on a minimum number of descriptors, it is uniform and stable, than seed can be certified and produced. On the other hand, cultivars with great phenotypic/morphological variation cannot be protected.

In the registration process, protection and seed multiplication of new cultivars, three different scenarios are possible: i) a cultivar may be registered by MAPA-RNC and not be protected by MAPA-SNPC, in which case, any seed producer approved by the MAPA can produce this

seed legally, ii) a cultivar can be protected by MAPA-SNPC only but not be listed by MAPA-RNC and in this case, the seeds of the cultivar cannot be produced and marketed legally, iii) a cultivar can be registered by MAPA-RNC and protected by MAPA-SNPC, in which case only producers with a license from the holder can produce seeds legally. The current trend is that public and private plant breeding companies have their cultivars registered by MAPA-RNC and protected by MAPA-SNPC.

Why protect

The legal possibility of registering and protecting cultivars must be exploited by both the public and private programs. In Brazil the company/institution breeding program need to ask for protection of new cultivars. Above all, protection is a way to prevent third parties from improperly exploiting the new cultivar with economic benefits. Protection does not necessarily mean to charge royalties, it just means that for the registration of any seed field, the seed company must have a license of the protection holder. So, for the species that have strong social focus, protection ensures that the holding institution will only grant a license to a seed producers who is committed to a social cause and can do so without charging royalties or charge a merely nominal value. In these times of globalization, protection can avoid the exploitation of protected cultivars by companies abroad during the duration of the protection period.

The cultivar protection increases the visibility of the institution to which the breeding program is located because seed producers have to know who hold the protection in order to apply for the license. Consequently, the institution is known for generating assets for society. By the market consolidation of more and more cultivars, the generating/holding institution becomes better known and respected. In the particular case of UFRGS oat cultivars, the need of the producer to apply for the license for oat seed production has increased the name and recognition of the breeding program and of the University itself. Many producers had been planting UFRGS varieties, rather unaware of who had developed them. Thus, the license has raised the awareness level of this service of the UFRGS for society.

Also for breeders, especially of the private companies and public institutions that do not market seeds in retail sale, the protection allows the registration of all licensed seed companies, facilitating a close monitoring of the cultivar performance in different years and environments of cultivation. The registration of seed producers is a direct channel of communication, where producers provide highly interesting information for breeders in relation to the acceptance by farmers and success of their cultivars. This feedback leads to changes in goals and methods in the breeding program.

The protection also promotes the dissemination of reliable information directly from the breeders to the seed producers. Seed producers play a leading role in the crucial process of a rapid spread of the new cultivars.

For society in general, the protection allows a cultivar that is actually superior to the others to be delivered rapidly to most grain producers, distributing the resulting benefits more equitably. A variety with high yield potential and/or resistance to diseases or insects can achieve the same yield in a smaller area, reducing fungicide/insecticide applications and consequently the environmental footprint left by agriculture. New cultivars keep the processing industry busy by providing products with better quality year after year, generating jobs and taxes. The cultivar protection allows more funds to be disposable for the breeding programs so that new cultivars can continuously be developed, in a virtuous circle of investment and development of better products for society as a whole.

Criteria for to be a registered/protected cultivar

With the possibility of cultivar protection and the facilities to conduct VCU and DUS trials by the breeding institution/company, a control mechanism has to be created by the breeder to prevent an excessive euphoria of to release varieties that are not better than those already commercially available. For example, the UFRGS breeding program created “UFRGS standards” for a commercial registration of a new oat line as a cultivar. The line is transformed into a new cultivar if all the following requirements are met: 1) higher or equivalent yield to the best market varieties, 2) stable yield across years and test sites, 3) grain quality and attributes that satisfy the processing industry, 4) good resistance to major diseases (crown rust, stem rust, black spot and scab), 5) an acceptable level of frost tolerance, 6) cycle adapted to exploit the growing season maximally, allowing the implementation of the crop rotation and succession system currently adopted by farmers in southern Brazil.

Seed handling

A key factor for the success of a new cultivar is the amount of seed available to farmers in the first year of release. It is therefore of great importance that breeder seed is produced with quality and in sufficient quantity during the trials phase of new cultivars. The flowchart of seed used in the UFRGS oat breeding program is shown in Figure 1. In the case of winter cereals, for the rapid distribution of a new line as cultivar in the last year of testing, the production of foundation seed must already be done on larger areas, by partner seed producers.

For some crops, e.g., common bean and rice, seed is only

produced after completing the final tests as follows: 1) after defining the line for registration, 500 seeds with the same phenotypic characteristic of the line are chosen, 2) the seeds are planted in pots in a greenhouse (500 pots), 3) the plant development is monitored and offtype plants are eliminated, 4) the plants are harvested and the grains are individually evaluated phenotypically and plants with variations are discarded, 5) the selected plants, with standard seed of the line/cultivar are sown in the field in a 5-meter row. The plant development is monitored and offtype plants are discarded, 6) lines are harvested and their seeds evaluated separately to eliminate any variation in the seed type (within and between rows), 7) after selection, phenotypically identical lines (plant and seeds) and the accurate characteristics of the cultivar are united to sow the first field/block of breeder seeds that will give rise to foundation seed.

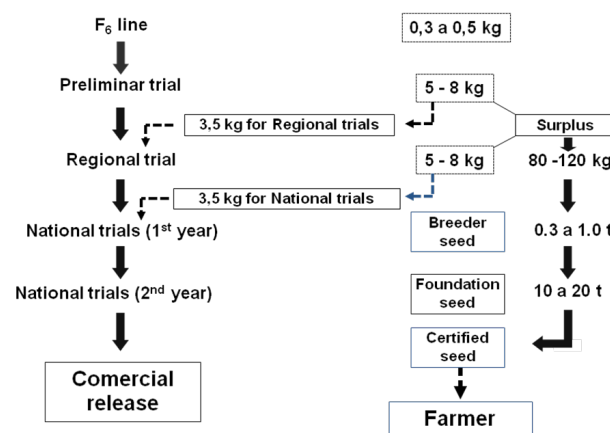


Figure 1. Flowchart of the seed production and yield tests of lines developed in the UFRGS oat breeding program.

For plant species where hybrid varieties are sold, as for example of corn, the development stages of inbred lines and hybrids are conducted directly by breeding programs on research stations. The breeding program is responsible for the initial seed multiplication of genetic inbred lines underlying the commercial hybrid. In general, 8-12 thousand seeds of the female line (pollen receptor) and male line (pollen donor) are produced in advanced generations of selfing (F₈ generation). The seeds are derived from 50-80 ears per line, which are individually harvested and threshed.

Breeder seeds are transferred to the seed production unit, which is responsible for multiplication and foundation seed production. At the seed production unit, the seeds of each ear coming from the breeding program are planted in a single row on the field. This allows the detection of possible segregation and/or variation within and between rows.

If phenotypic variation is observed, the line is eliminated and the others are harvested and threshed in bulk. The seed unit produces around 600 kg of foundation seed per line. Foundation seed is transferred to the seed production unit, which is responsible for the multiplication of certified seed on a large scale. The hybrid seed is produced on isolated fields and under strict pollination control in order to avoid any cross-contamination by unwanted pollen.

Partner choice

Some institutions besides a breeding program they have a seed production system with infrastructure accredited by the national seed registration RENASEM (RENASEM Producer), with qualified personnel, administrative staff and all regulatory system in place (expense voucher, general Tax-payers' Registry-CNPJ and State Registration-IE) for legally produce foundation seed. However, the production of this seed category can be outsourced to partner seed producers.

When the breeding program has no proper system of production and marketing, the choice of the first seed producers for the production of foundation seed is a decisive factor in the success or failure of a new cultivar. Therefore, some desirable attributes must be taken into consideration to select partners, for example: 1) the quality of seed production (recognized excellence in seed production), 2) knowledge and tradition on the seed market, 3) low risk (high production potential per area and low climate risk), 4) ethics, 5) previous successful partnerships, 6) and market niche (place of location in the area of highest demand).

Private companies have a business plan for each variety based on which they produce and sell the seeds. Unfortunately, most public institutions cannot do the same due to the lack of human resources, the restrictive legislation controlling public funds and the lack of autonomy required to register seed fields and sale, since many of these institutions are linked to the Federal and State administration. The entire legislation related to seed production, based on Law No. 10.711, of 05/08/2003 and regulated by Decree No. 5153 of 23/07/2004 and other frequently updated MAPA Normative Instructions (Brasil 2007), can be downloaded at www.agricultura.gov.br. In most cases, the public programs have to perform auctions to sell breeders seed to the highest bid, which is not always the best seed producer.

Advertising and marketing

The new regulatory framework increased pressure on breeders to commercially release new varieties and greatly strengthened marketing and advertising teams, mainly of private companies. However, the Seeds Law (Law 10711, August

5, 2003) has brought a new component, it permits that a class of seed can be obtained only from a previous class, and thus once the breeders seed is produced, the variety has a market life of six years if no new breeders seed is produced. For the first time, this set of conditions allowed the development of a strategy for the monitoring of every new cultivar and to accurately determine its market life. On the other hand, the responsibility of breeders increased greatly, so as not to be deluded by the marketing numbers and only allow the release of cultivars with superior agronomic characteristics. For this, breeder should be present and participate actively in the development of marketing strategies of cultivars and discuss the limits of these actions. In this context, the participation of the breeder as part of the process of seed production and cultivar spread is essential for the success and adoption of the technology. It also promotes the prospect of demands for any future registrations of new cultivars. Increasingly, the approximation of the breeder to the production system, farmers and third seed sector has helped detect problems and qualities of commercial cultivars, sometimes undetected in the preliminary and final trials prior to registration. This is due to the expansion of the cultivated area (large scale), technological level and history of the farmer's fields.

In this increasingly competitive world, information has become fundamental in decision making and the asymmetry in information between breeding programs, seed producers and grain producers in general permits that not always the best cultivars dominate the market spaces. The private breeding companies with well-developed marketing teams and much more experience in competitive economy, soon extended their lead in this new scenario. Moreover, these companies have resources enough to send salespeople to farms for direct negotiations with the grain producers. The dissemination strategies of new cultivars vary widely and depend on the market size and importance of the species; whether the company is public or private and on the available human and financial resources for marketing. Most public companies still organize field day events and scheduled technical visits, where the future cultivars are demonstrated to major seed producers. Public companies are searching for alternatives such as Foundations (Foundation MT in Mato Grosso, Meridional in Parana and Pró-Semente in Rio Grande do Sul). Gradually, more activities are being planned and developed with a focus on different market segments of different crops. A good example of the activities arising from foundations was presented by Tavares et al. (2011) in a description of transfer activities of the new wheat cultivars developed in Paraná. These authors described the use of a systemic methodology, and the following action strategic and transfer methods: 1) field days, 2) technical meetings, 3) visits of specialists, 4) demonstration units. With the partnership, the market share of Embrapa cultivars increased gradually in a sustainable way (from 15% in 2003 to 47.5% in 2009).

Partnerships are organized around private foundations organizations, with the specific purpose of developing, producing and licensing new plant cultivars, provided that this license is legally viable. This can be complicated, in the case of cultivars from public institutions because it is difficult to give exclusive rights of a cultivar as normally done by the private sector. The foundations offer flexibility for the partners in terms of cultivar licensing and allocation and use of financial, human and material resources. The interaction between partners is defined and specified in terms of rights and obligations, tending to reduce the transaction costs associated with the project (Carvalho et al. 2007).

For some plant species that are raw material for the manufacturing industry, a company (industry) may coordinate the production chain. This company can deploy resources for scientific research (breeding and management), informing the suppliers (grain producers), which cultivars with which characteristics the company will buy, provided

they are approved by the RNC. Meetings of the breeders with producers are annually scheduled, where cultivars are presented in lectures and visits to the experimental field and also to the seed production fields and where the results obtained by each cultivar are discussed.

On the other hand, there is already a clear trend that more field days and demonstration plots are explained by marketing staff of companies than by breeders. Obviously, since the number of field days has increased, the breeder can impossibly be present at all of them, but it is imperative that he should participate in the most important, to explain the main characteristics of the new cultivar to the farmers, about the agronomic management and about advantages and potential problems. This effective participation of breeders will certainly reinforce the marketing strategies to introduce new cultivars properly, since the marketing staff is not always sufficiently prepared to meet the information needs by the farmers.

Trabalho dos melhoristas após a obtenção das cultivares: etapa da recomendação

Resumo – *O desenvolvimento de uma nova cultivar representa o objetivo final dos programas de melhoramento genético e é fruto de muitos anos de trabalho e esforço dos melhoristas e suas equipes. Uma parte importante do processo muitas vezes negligenciada pelos melhoristas é a etapa da recomendação a produção de semente genética (pós-melhoramento). Neste trabalho são discutidos o papel do melhorista na recomendação, registro, proteção e marketing das novas cultivares. O envolvimento do melhorista em todas as fases do pós-melhoramento é de fundamental importância para que a cultivar chegue rapidamente aos agricultores e possa proporcionar os ganhos esperados pela sociedade.*

Palavras-chave: *Varietades, marketing, divulgação, semente genética, pós-melhoramento.*

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