PRECOP Information Sheet Nº 17

GRAIN HARVEST EFFICIENCY IN ARGENTINA

The machinery market in Argentina and harvest efficiency

In the past 16 years, Argentina has developed its production from 37 to 84 million tons of grains; Soybeans in particular represent 54% of the area planted, growing in 9 years from 12.6 million tons to 42 million in crop year 2004/2005.

Between the years 1996-97-98, an average of 1,577 harvesters were sold per year, while between 1999 and 2002, the average was 651 harvesters per year. This mismatch between supply of machinery and the increase in demand for greater production caused a serious problem of loss of harvest efficiency, which, towards the end of 2002 led to a consciousness-raising campaign on the subject from INTA, which had its fruits in the level of equipment and in the emergence of the national PRECOP project towards the end of 2004.

The lack of equipment hinders harvesting services being provided properly and on time, and causes problems of inefficiency in collecting that represent 754 million dollars of losses in the eight main crops in Argentina. With the ideal level of replacement of harvesting equipment that would solve supply problems in this area, losses could be reduced by 20%, recovering 150 million dollars per year for Argentina, just in harvesting the eight main grains in the country (Table 1).

Table 1. *Harvest losses in the eight main grain crops in Argentina. Source: INTA Manfredi 2005.*

Crops	Area harvested (ha)	Losses (kg/ha)	Losses (t)	Value (US$/t)	Losses (US$)	20% reduction of losses
Soybeans	14,700,000	166	2,440,200	203	495,360,600	99,072,120
Maize	2,180,000	385	839,300	77	64,458,240	12,891,648
Sunflower	1,800,000	135	243,000	206	50,155,200	10,031,040
Sorghum	572,270	341	195,144	88	17,094,621	3,418,924
Wheat	5,950,000	135	803,250	119	95,426,100	19,085,220
Peanuts	157,326	293	46,097	520	23,951,751	4,790,350
Beans	70,000	135	9,450	180	1,701,000	340,200
Rice	110,000	270	29,700	220	6,522,120	1,304,424
Totals	**25,202,270**				**754,669,631**	**150,933,926**

As well as the losses before and during harvest, in the post-harvest – storage, drying and freight – Argentina loses another 700 million dollars. As no post-harvest system can improve the quality of the grain – in the best of cases it can maintain it – it is fundamental to begin the end quality process well, from the moment the grain (food) is stored in the plant before its mechanical collection. The end quality is conditioned from the planting of the crop up to its destination as a food.

The guidelines behind official policy decisions, as well as the private agrifood sector with its heavy investments (more than 800 million dollars for the next few years), seem to indicate that every effort is being made to have a country with strong orientation towards the production of agrifoods with high value added, that plays an ever more important role in world trade in this area.

For Argentina to situate itself definitively in the place it deserves for its potential as a food-producing country, it is necessary, among other questions, to identify the problems that today limit the desirable development of harvest and post-harvest efficiency and in grain quality. The market of harvesting machinery, and the causes and consequences of its fluctuations are basic points in the chain towards efficiency in grain production in the country.

→ *Machinery market*

The year 2004 was good for Argentine agricultural machinery because there was the euphoria of the first five months of the year, with high profits from soybean farming, with values of between $600 and $700 per ton. Soybeans grown with input and land cost values some 20% below current values left remaining profit to invest.

Faced with a demand highly anxious to obtain harvesters, tractors, planters and sprayers – to some extent not satisfied by the supply – in the first months of 2004 there were early sales that cushioned the fall in the market as from August, as several factories had 100% of their production sold 4 months before the end of the year.

2004 ended with a total of investments in machinery approximately 21.2% higher than 2003 that had been very good; remember that 2003 ended with an increase of 141% compared to the very depressed 2002 (Figure1). To sum up, 2004 was a record year with a 193% increase in sales of agricultural machinery compared to 2002, which was also a record year but for low sales.

Evaluated in millions of dollars, 2004 was 9.3% higher than 1997, another record year of the international soybeans price. It should be pointed out that with 1 dollar of the year 2004, more machines could be bought than with 1 dollar of the year 1997.

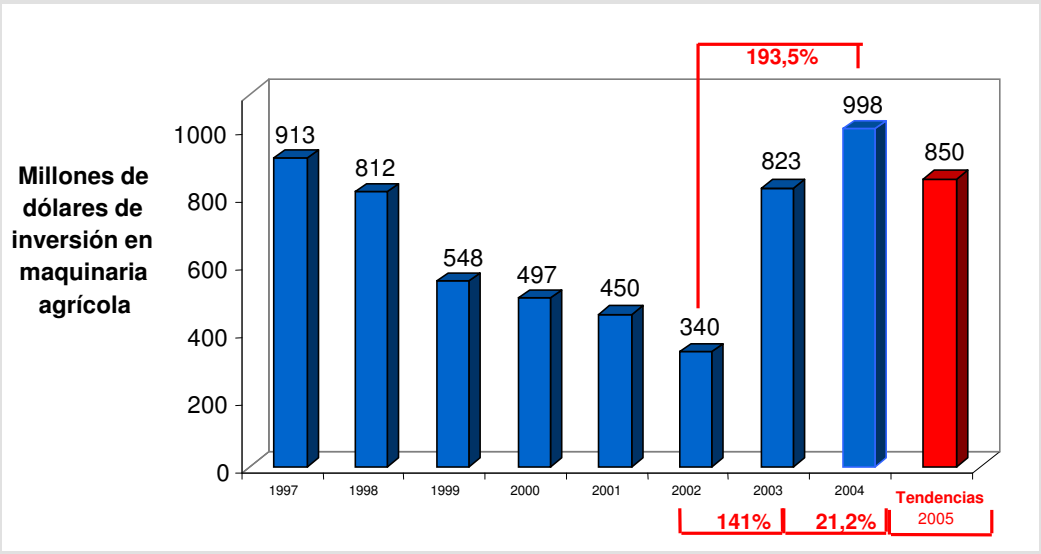

Figure1. *Investment in agricultural machinery in millions of dollars. Source: CAFMA. AFAT, INTA Manfredi – RATE 2004 – US$1 = AR$3*

Note: *This chart includes for the years 1997 – 1998 sales of machinery for regional crops, such as harvesters for cotton, harvesters and lifters for peanuts, and some specific machinery for beans and rice, which as from 1999 up to the present have almost disappeared from the market, as have tilling tools; this explains, in part, the sharp fall in total investments in machinery that have occurred in the country.*

→ *Argentine harvesters market*

Within the recovery experienced in investments in agricultural machinery in Argentina as from 2003, it should be noted that the area of greatest growth in sales was that of harvesters, with 316% compared with the year 2002, provoked, among other things, by a recovery in the international cereals prices. It is important to see that the greater sales of harvesters pulled up the sales of tractors by 312% compared with 2002, as the grain is moved during the harvest with ever-larger hopper trailers, requiring new generation tractors with greater power and agility (Figure 2 and 3).

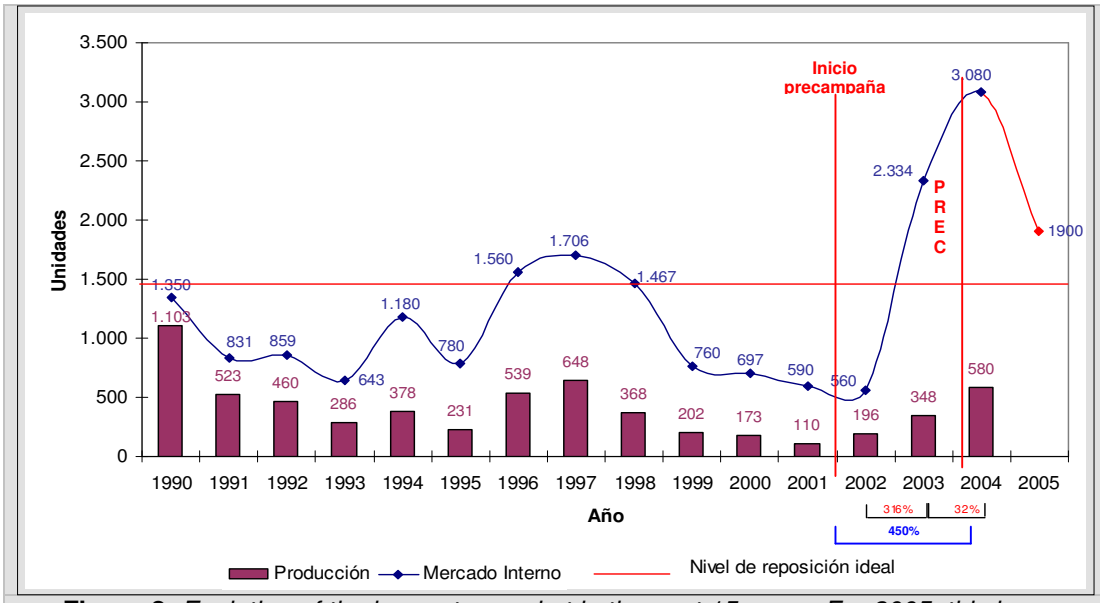

Figure 2. *Evolution of the harvester market in the past 15 years. For 2005, this is an estimated trend (Source: INTA Manfredi 2004).*

It was evident that the record harvest of 84 million tons of the crop year 2004/2005 was brought in more quickly than in previous years, with the harvester bringing in grain with little climate damage and scant pre-harvest losses in the crop, in good time, and suitably ripe. All this was a significant contribution for achieving the longed for harvest efficiency that the INTA PRECOP Project is aiming for. A good number of harvesters are still needed in Argentina to make it possible to reduce the average forward speed of the harvesters in the field, which would obviously result in a drastic reduction in losses caused by the harvester (header and tail), also improving grain quality as it reduces the rate of the threshing cylinder, and so the mechanical damage to the grain. A lower feed index to the separation system and fundamentally of cleaning also permits cleaner grains, without dirt, in the harvester hopper, which improves its storage and its quality in the industrialisation process.

Summary: Argentina has seen an improvement in the availability of harvester supply. Now the harvester waits for the crop and not the ripe crop for the harvester. So there has been a reduction in pre-harvest losses, and a reduction of climate loss risks.

On the other hand, Argentina does not currently have sufficient harvesters to harvest 84 million tons at a suitable speed, which would make it possible to have even lower losses and healthier and cleaner grain.

Argentina wants to grow in area and productivity until it reaches 100 million tons in 2010; so it must replace no less than 1,900 harvesters/year in the next 4 years.

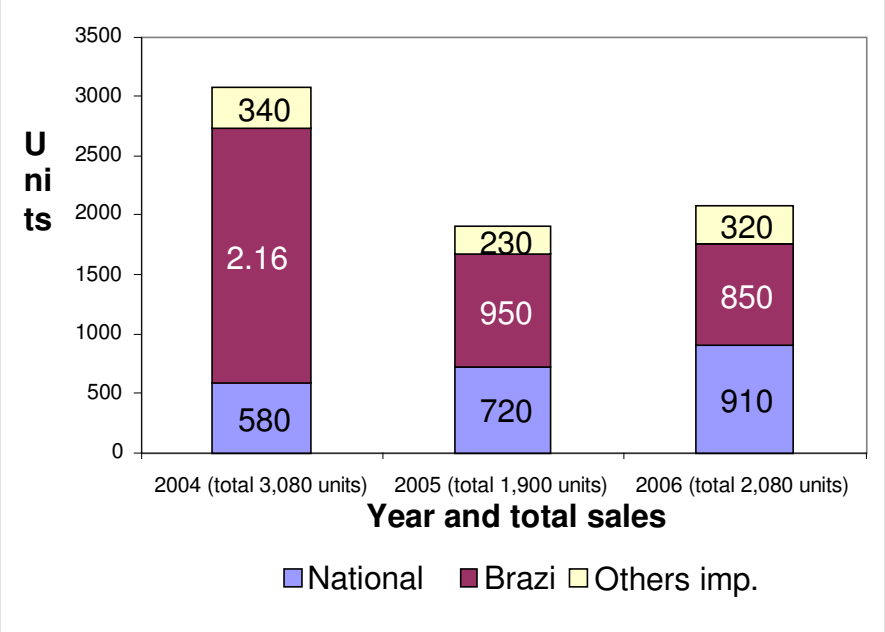

Figure 3. *Estimated trend in quantity of harvesters sold by origin. For 2004, and projections for 2005 and 2006. Source: INTA Manfredi.*

→ ***The world market of harvesters and Argentina's place in the market.***

	Number of Harvesters		
Variation	2004	2003	%
Western Europe	6,380	6,800	0.44
Central European Countries (New members)	1,300	1,600	-18.75
Ex-Soviet Union countries	1,400	990	41.41
USA	7,500	6,200	20.97
South America	10,300	8,000	28.75
Australia	995	910	9.34
Other countries	1,080	635	70.08
Totals	**29,405**	**25,135**	**16.99**
American continent (USA, Brazil, Argentina, and others)	60.53 % of market at world level		
Argentina	**3.080**	**2.354**	**30.8**

Figure 4. *World Market for Harvesters. Source: INTA Manfredi.*

Argentina with its 3,080 harvesters sold during 2004 represents no less than 10.4% at world level. As it is estimated that the world harvester market will remain steady at about 30,000 harvesters per year, and Argentina with

2,000 harvesters per year, on average, the Argentine Market represents 6.6%.

→ *Market for Maize Headers*

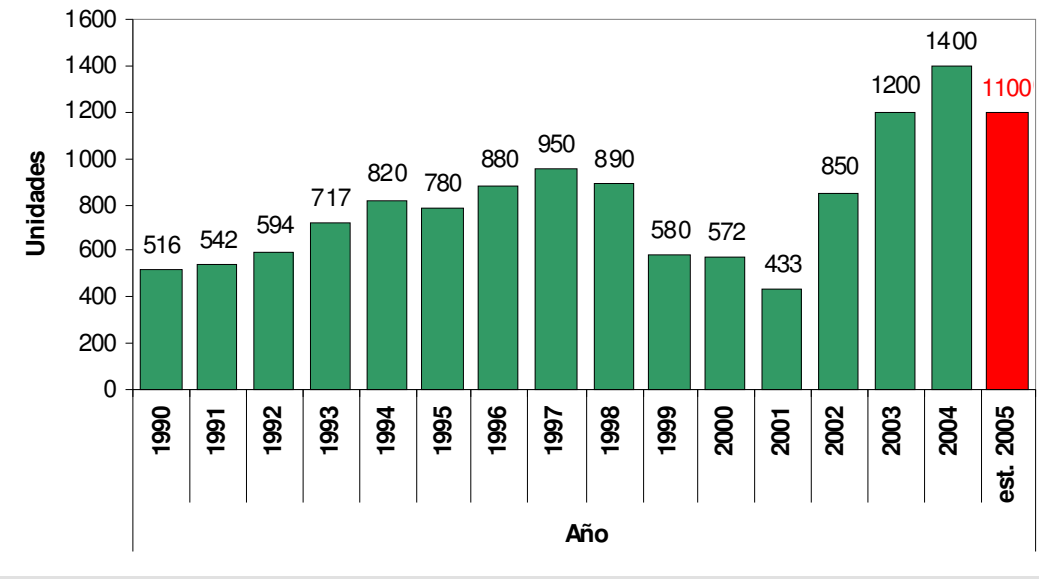

Figure 5. *Units of maize headers sold in Argentina in the last 15 years. Source: INTA Manfredi.*

Faced with the barrel of petrol quoting at US$60, crops like maize that depend heavily on Urea and the UAN (petrol), and with the sea-freight price very high, with a ton of maize below US$100, the future of the crop and its competition against soybeans, makes it difficult to maintain the planting area, and so the sustainability of the soil is put at risk for the loss of carbon that is occurring year after year in the productive systems of intensive farming.

On the minus side, if there is no change in the macro policy to improve the profitability of maize farming and its competitiveness against soybeans, a reduction can be expected in the planting area of the order of 15% in the 2005/2006 crop year, which will affect the sales of headers, since the harvestable area for this crop is unlikely to be more than 2,300,000 ha, and for this demand, current headers are sufficient.

On the plus side for the sale of headers are:

1. The increase in sales of harvesters, with an estimated 3,080 units in the 2004 crop year, and the not inappreciable number of 1,900 harvesters for 2005.

2. The nearly universal change of spacing between rows from 70 to 52.5cm leaves a significant number for changing over.

- ✓ Greater collection demands for higher current crop yields (D.D., genetics, simple and Bt. hybrids, balanced fertilization, pneumatic planting, crop rotation). To harvest maize at 15,000 kg/ha, modern, robust headers are necessary, and new generation harvesters.
- ✓ Another favourable point is the high performance, technological competitiveness and properties of the national headers compared with those from Brazil and the USA, with significant price advantages in favour of the national ones.
- ✓ Ageing of the stock and the need for re-equipment, lack of accumulated replacement. Between the years 1999, 2000 and 2001, the market was at 50% of the ideal replacement level (1000 headers/year), and so there is a significant lag in equipment.

→ *Market for Sunflower Headers*

Sunflower header sales have been falling year by year (Figure 6).

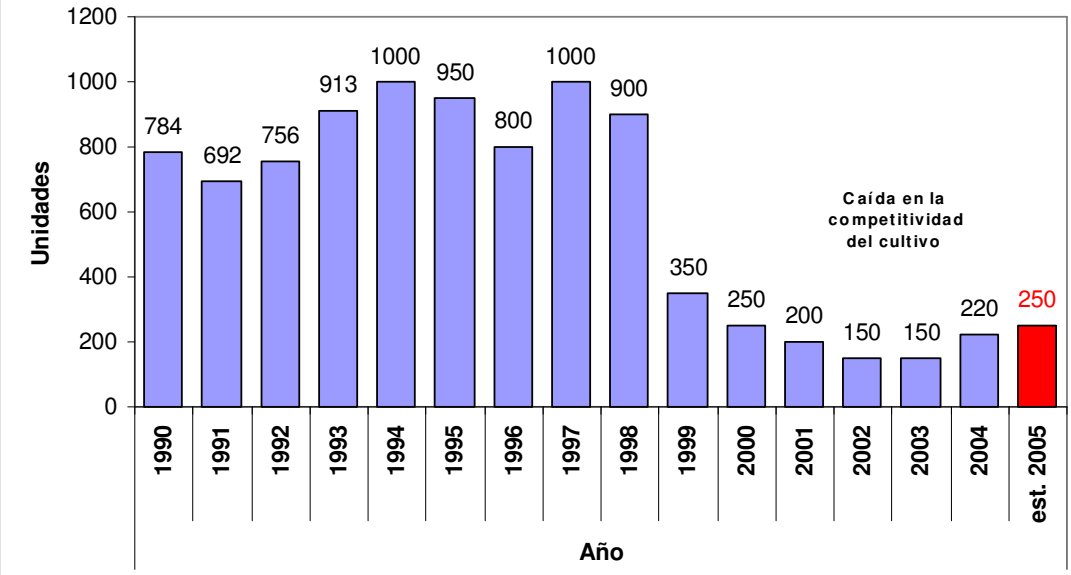

Figure 6. *Estimate of sunflower header units sold in Argentina in the past 15 years. Source: INTA Manfredi.*

The planting area continued falling for various reasons in the crop year 2004/2005; one of these was the drought that occurred during the spring in the sunflower area, and another, the lack of competitiveness with the soybean crop, mainly for its heavier investment in seeds, fertilizers and herbicides, and the latter because there are no RR sunflowers yet.

→ *Analysis of the drop in the market for Sunflower Headers*

- Drop in the sunflower planting area.
- Great durability of the equipment.
- Little technological innovation; only improvements in functioning.

An encouraging note for sales is the accumulated ageing of the market that now has 5 consecutive years of very low sales. Ideal replacement figures are around 700 headers/year, while the average of the past 5 years has been 220 headers/year.

A positive point is that a 10% to 15% increase is expected in the sunflower planting area for the 2005/2006 crop year.

→ *Self-unloading hopper market in Argentina*

The self-unloading hoppers that accompany the harvesters have not been many years in the market. They started back in the 90s, and gradually began replacing the traditional 6 to 8 ton hopper, two axle trailers, with gravity unloading, used nowadays for reloading planters with seed and fertilizers. These trailers have high pressure truck tires (100 lb/in^2) (Figure7).

The development of unloading hoppers to replace the traditional hoppers not only manages to improve the task of smoothly extracting the grain from the field with high capacity harvesters – 70 ton/h of maize – but also eases the loading of trucks with the correct weight with electronic scales, the filling of silo bags, and also brings benefits to the direct drilling farming systems, as it replaces the high pressure (100 lbs/in^2) tires of traditional hoppers with 30 lbs/in^2 tires, 3 times less pressure on the soil, reducing tracks and compacting of the soil.

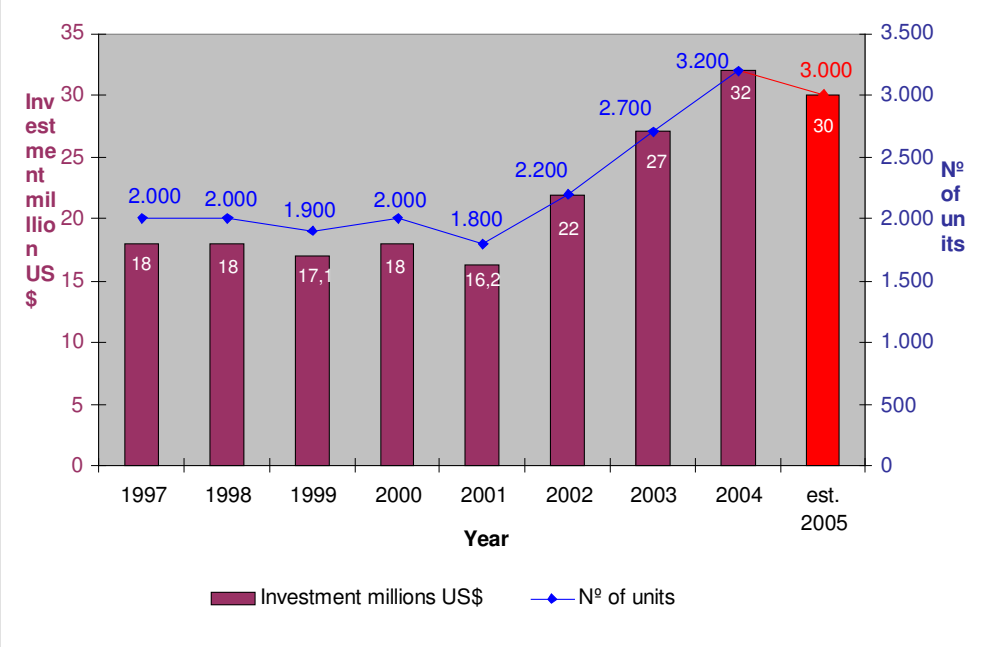

Figure 7. *Evolution of the self-unloading hopper market in Argentina during the last 9 years. Source: INTA Manfredi.*

Projected on average of 7 years, indicates sales of 2,085 hoppers/year.

The single axle hopper market represents currently 55% of the total. Of these single axle hoppers, 60% of the market is14 ton hoppers, 15% hoppers under 14 tons (from 8 to 12 tons), and 25% hoppers with more than 14 tons (16-18-20-22-24 and up to 26 tons).

In the two axle market – 45% of the market – hoppers can be found from 16 to 25 tons. Within these hoppers, there are two well-defined sizes, 16/18 tons and 20/22 tons, a large proportion of which have four equal wheels (more than 50%).

The trend will remain of 55% of one axle and 45% with two axles, but tonnage will increase in both models.

→ *Technological trends in Harvesters*

- ✓ Improvements in soybean headers, cutter bar, automation of the belt control, self-leveling and programming of the reel, improvements in side separators adapted to the crop at 30° and distances of less than 52.5 cm between rows.
- ✓ In soybean headers there are some advances in kits of metal sheets for retaining the shell-out of soybeans caused by the cutter bar and the reel, which offer significant advantages in reducing losses from the header, and these should be adopted.
- ✓ Improvements in threshing efficiency, to reduce mechanical damage to the grain.

- ✓ Greater hopper capacity and improvement in unloading (more kg/min. with less mechanical damage).
- ✓ Improvements in the movement systems of combines, tires with lower inflation pressure to prevent tracks and compaction, if possible with radial and non-aggressive lug pattern.
- ✓ Improvements in treatment and distribution of the straw and chaff leaving the combine tail.
- ✓ Ergonomic improvements in the command position, more information and greater automation.
- ✓ Greater reliability in electronic equipment: header automation sensors and other aspects of the combine.
- ✓ Improvements in electronic devices and software. Improvements in hardware: loss monitors, feedback monitors, yield monitors with satellite mapping.
- ✓ Improvements in safety: IRAM safety standards met.
- ✓ Greater header width, greater power, less specific consumption of engine, better after-sales services, greater training of operators who, from now on, will not only harvest grains, but collect natural and induced variability data, reflected in the yield maps.
- ✓ Greater adoption of combines with axial rotor to reduce mechanical damage to the grain and improve quality.
- ✓ Greater adoption of centrifugal separation shakers.
- ✓ Greater adoption of twin rotor axial separators, replacing the straw removers, mainly in demanding crops such as high-yielding rice and wheat.

The 30 foot wide headers for soybean crops placed in combines with engines of more than 320HP seem to be insufficient to "fill" this kind of machine with high harvest index group IV soybeans without weeds.

The solution is not increasing the forward speed of the harvester, but in increasing the width of the header from 30 to 35 and even 40 feet (12 cm in width). For this a maximum of industrial ingenuity will have to be used, and the challenge will be to manufacture twin soybean headers, i.e., twin blade, twin belt, twin reel command, which reduces the risk of breakage and lightens the header, which must be constructed with a lot of plastic and aluminum.

→ *Technological trends in headers*

. Technological trends in a modern maize header

1) Easily regulated, low and sharp profile points and shields, with a simple and rapidly removable folding system. Light, preferably plastic, construction material.

2) Collecting chains with large width for plant input and concentric infeed section, easily regulated for speed and tension.

3) Square or pentagonal profile stalk rolls; conical trunk design with easily changed folded metal sheets with cutting edges, that make a crack in the stalk without cutting it, but making it more fragile.

4) Stripper plates with a design to prevent wear and cutting of plants, and also with easy mechanical regulation, preferably hydraulic or electrical from the operator's cabin, with a reference indicator situated in a place visible to the driver.

5) Easily-regulated, wear-resistant grass plates

6) Rubber stalk retention valves, well designed and easy to change.

7) Belt with high wing height for large size ears. Cogs intercrossed in their central part for central feeding of threshing cylinder. Central delivery paddles with tangent design to avoid the ears flying. Highly sensitive and long-lasting belt latches.

8) Reinforced wire screen located over the feederhouse to prevent the ears flying off the belt.

9) Side points with sharp design, and a smooth and high profile, with their upper part broad in order to guide the plants without causing loosening of the ears.

10) Light headers, easily adaptable to the different distances between rows from 52.5 to 70 cm.

11) Control boxes built in light material, equipped with individual latches per row (body), with high sensitivity and durability.

12) Complete safety equipment, as far as possible under IRAM standards. Protection of all moving parts, warning stickers, and of basic regulations, with detailed working instructions.

13) Manual of correct maintenance and functioning, with basic regulations depending on the stage of the crop.

14) Easily adaptable header turn speed for different conditions of crops and harvester.

15) Good mechanical assistance and customer attention, with availability of spare parts in all the country.

16) The maize headers nowadays must respond to a shortening of the distances between maize rows from 70 to 52.5 cm., which makes them heavier because there is a greater number of rows for the same harvesting capacity. On the other hand, demand for larger sized combines is still growing, which means the width of the header will have to increase to maintain the forward speed at acceptable levels. These two factors oblige new materials to be

used for building headers; there are already 22 row headers at 52.5 cm in Argentina, equivalent to a working width of 11.55 m. This means that in some cases aluminum has to be used in the frame, plastic in all the shields and points, and now also plastic or polymers in the chain guides. There are even lifting chains for the row unit, in plastic (polymer) materials now in an experimentation period in another trend to reducing. Still to be redesigned are the controls below the header and not at the extremes, to remove moments from the frame that cannot be stood up.

. Technological trends in a modern sunflower header

1) Light equipment with great working width: 12 to 14 rows (Group 2 harvesters), or 14 to 16 rows at 70 cm (Group 1 harvesters).
2) Fixed shield or revolving drum type with good diameter and easily regulated, as far as possible, hydraulically or electrically from the cabin with accompanying movement of the reel, with no need for using hand tools.
3) Reel with broad sweeps arranged helicoidally, with hydraulic height regulation (if possible with modification of continuous turn from operator's cabin).
4) Improvements to cutting systems adapted to the new forward speed conditions and stem diameter. System of greater cutting surface and blade control with a speed not less than 450 turns/minute.
5) Pans with regulation of their spacing (throat), easily regulated to adapt the equipment to different diameters of stems and capitula.
6) Easy adaptation of position of the pans to the different heights of the sunflowers to be harvested, by varying between header and feederhouse, or between pan and header (instruction stickers with diagrams).
7) Stem-remover with easy regulation of height and progress, equipped with self-cleaning counter-knife.
8) Regulation of the turning speed of the whole header with a hydraulic control worked from the operator's command post. This is standard equipment in only a minority of harvesters, so it would be equipment to be added to the header.
9) Speed of reel, belt, cutter and stem-remover coordinated automatically depending on the state of the crop and the forward speed of the harvester (new generation harvester CASE AFX 8010, 20% + and 20% - in the turning speed of automatic header with the forward speed).
10) Wire screen to prevent fall of capitula behind the header, placed perpendicular to the operator's line of sight.

11) Lateral separators or long, sharp, high, closed "points" to avoid losses from deheading of capitula.

12) The equipment must meet all the safety standards for the operator, and also have stickers and operator's manual, indicating the basic regulation of the header for variations in the condition of the crop.

13) Sunflower headers should also have a kit of special adaptors to collect sunflowers with fallen plants.

For completely flattened sunflowers, the header should be specific, and this is a subject still pending for the national industry. Even though the market is small, the economic value of the losses year on year is significant, and nowadays, faced with completely collapsed fields, there are three alternatives: complete loss of the field, hand collection as done last year in the north of the country, or the use of some excellent headers imported from Italy with rotating cutters, lifting chains formed with belts, points and special shields.

. National innovation in technology in soybean headers

The important technological innovation for soybean harvesting from the past year in this country that should be mentioned is a device developed by a Córdoba farmer, that is remarkable for the simplicity of its manufacture, practicality of fitting, and its results in harvesting in the field.

It consists of a series of metal profiles, bolted to the points of the header. This device was evaluated by INTA technicians harvesting soybeans, and showed reductions in losses from header shelling of up to 45% compared to a traditional header at high harvesting speeds (Figure 8).

Figure 8. *Losses in kg/ha in soybeans caused by the header at three forward speeds of the machine, with and without retaining metal sheets respectively. Fewer losses at all forward speeds with the kit of retaining metal sheets. Harvester JD 1175 A, header JD 916 model 2001, Soybeans 6445. Source: INTA 2004.*

The behavior and features of this device make it appear a candidate for later stages of development and marketing.

→ *Advances in Harvester Electronics and Sensorization*

The other great technological novelty in 2004/2005 was the advance made by the firm “Sensor” which developed a very good sensorization of all the national Vasalli harvesters – Don Roque, Bernardín, Marani Agrinar and Metalfor. They all have CAN systems and liquid quartz multi-function screen (Figure 9).

Figure 9. *Examples of national command consoles for latest generation harvesters. Left: Vasalli 1550, right: Metalfor Araus.*

→ *Technology trends in self-unloading hoppers*

The trend in unloading hoppers is an increase in load capacity and modifications added to the transport systems tending towards higher floatability with less specific pressure on the soil (radial tires, caterpillars, etc.).

To this is added the trend to maximize safety standards in manufacturing equipment and give them a more appropriate design for sea-export to the European Union countries, including plastic in hopper construction and in bolting the chassis, to ease movement in containers.

→ *Harvest and grain quality*

There is a direct correlation between mechanical damage produced in the grain during harvest and the damage during storage, whether or not the destination is for industrial use or as a seed.

It is also known that grains can be damaged more easily during harvesting when they have excessive humidity, not having completed the ripening cycle, and in this case they need more aggressive threshing for their separation. The opposite occurs when grain humidity is low, as their fragility increases as they face the mechanics of threshing and the rest of the movements inside the harvester. Every crop therefore has an optimum range of humidity at harvest in which it has more tolerance to mechanical damage. From the state of supply of harvest equipment explained earlier, in which most of the time the equipment is not available properly and on time, leading to greater likelihood of mechanical damage, it is necessary to pay attention to the times and places where damage may occur.

→ *Times and places where mechanical damage may occur in the grain and where the farmer should pay attention to improve handling.*

- ***Time***
  - ✓ Development of crop ripeness, plant health (diseases and pests).

- ***Places***
  - ✓ Shelling at the header, unprotected grain, with less humidity and greater fragility.
  - ✓ Shelling at the feederhouse, unprotected grain with less humidity and greater fragility.
  - ✓ Mechanical damage during threshing from already threshed grain from previous processing entering the cylinder.
  - ✓ Damage from excessive impact (excess RPM of the threshing cylinder).
  - ✓ Damage from excessive friction from poor regulation of cylinder/concave (appropriate separation, greater opening in front; progressive threshing).
  - ✓ Delay in sieving the concave (already threshed grains that remain in the threshing process).
  - ✓ Excessive return (already threshed grains that remain in the threshing process).
  - ✓ Damage from belts and pulleys in poor condition (worn and sharpened belts and dented boxes).
  - ✓ Breakage from the harvester hopper unloading belt (excessive RPM and slope).
  - ✓ Other mechanical causes of grain breakage on the farm.
  - ✓ Breakage during unloading in self-unloading hoppers.
  - ✓ Breakage during bag-filling (silo bags).
  - ✓ Breakage from extractor belts (silo bags)

- ✓ Breakage from unloading belts of traditional silos without chain dumps.
- ✓ Breakage from hopper belts. (silo/hopper/truck).
- ✓ Pre-cleaning belts before destination (freight truck).

The trend in harvesting technology aims at reducing mechanical damage in the threshing process by placing accelerators with grain sieves in front of the conventional threshing cylinder, for the drier and more fragile grains to be sieved before reaching the main cylinder and thus suffer the least possible mechanical damage.

Another ally is the high inertia cylinder or placing fliers to be able to reduce the RPM of threshing without damaging the variator belt. For soybeans, the replacement of the conventional cylinder bars with flattened-type toothed bars or the choice of axial rotors offer undoubted advantages, making a progressive threshing with fewer turns inside the threshing concave. Bear in mind that the material threshed may make six turns inside the concave/rotor before passing to the separation process; so the drier grains can make one turn and be sieved, and the damper and more resistant make six turns before being threshed and sieved.

The internal movement of the combine and the unloading of the belt are other factors of mechanical damage for grain within the harvester: the unloading belts will reduce mechanical damage to the grain the more horizontally they work, the greater diameter they have, and working with the least number of turns; the return sensors will offer great advantages in reducing mechanical damage to the grain, as all grain that returns to the main cylinder has a high possibility of suffering some kind of mechanical damage.

The quality standards in soybeans, maize and especially wheat for the next crop year will be very strict and will have a high incidence in the farmers' income level. Working on the efficiency of grain handling during harvest and post-harvest will be one of the priority tasks for the INTA PRECOP project during the next crop years.

Authors:
. Mario Bragachini (Coordinator INTA PRECOP)
. José Peiretti (Technician INTA PRECOP)

Design and Diagrams:
. Daniel Damen (Communications, INTA PRECOP)

PRECOP PROJECT
Executive unit: INTA EEA Manfredi.
Ruta 9, km 636 (5988). Manfredi, Córdoba, Argentina.
Tel./Fax: (03572) 493039
Email: precop@correo.inta.gov.ar

Website: www.cosechaypostcosecha.org