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Economic impact of neonicotinoids and phenylpyrazoles in the Argentine Agribusiness System

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Buenos Aires, May 10th, 2016

Context

- They are insecticides introduced into the market in the year 1990 and ...
- ... have a **spectrum of control which is more reduced than the average of the insecticides**, and the dumping action is intermediate while the persistence is average, which implies...
- ... they have a **clearly defined objective and reduce the possibility of causing collateral damage**
- **Neonicotinoids** imitate the action of the neurotransmitter acetylcholine which block the receptors and interrupt the impulse transmission among the nerve cells
- **Phenylpyrazoles** block the chloride channel activated by GABA (main inhibitory neurotransmitter in the insects), which cause hyper excitement and convulsions
- **Its use is criticized in Europe and the United States**, to the point that certain supermarkets do not sell those products that may have been in contact with this insecticides

Content

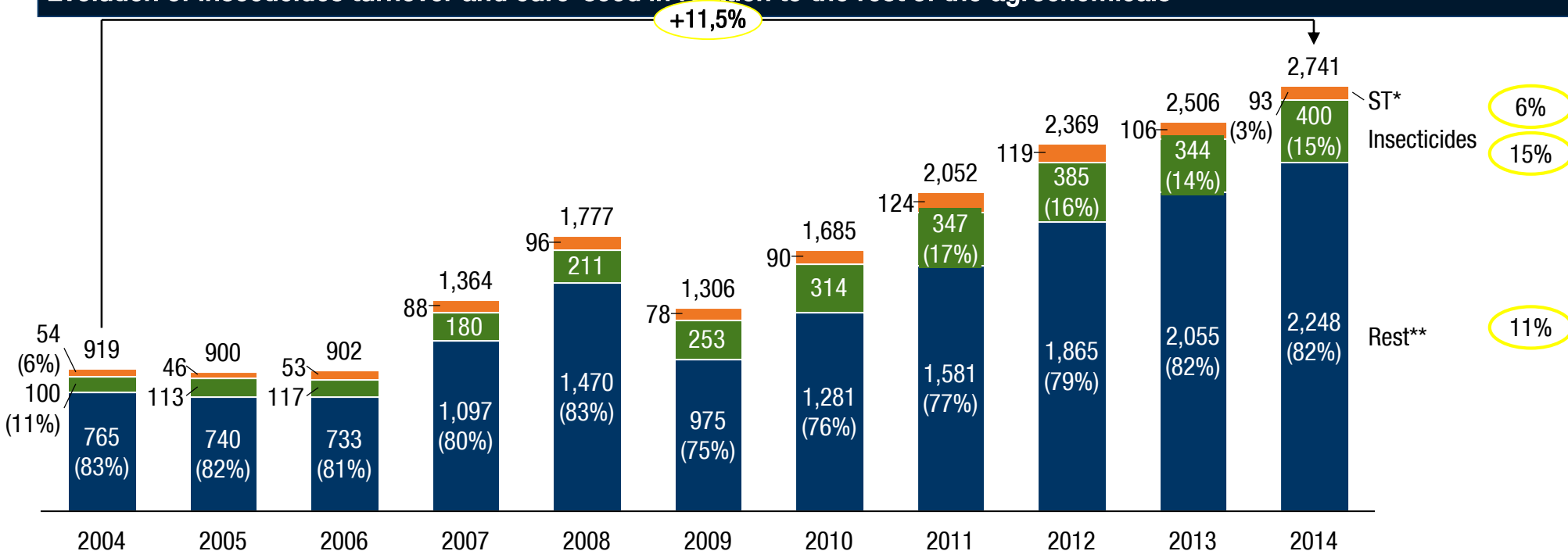
- **Strategic importance in the Argentine agriculture**
- Farmer's benefits related to the soybean crop
- Social and economic impact of technology

In the last decade, the turnover of products for seed treatment has doubled, while that for insecticides has quadrupled

Millions of USD.

CAGR

Evolution of insecticides turnover and cure-seed in relation to the rest of the agrochemicals



- Insecticides turnover has grown at a faster pace than the whole group of agrochemicals, increasing its share over the agrochemicals, while...
- ... seed treatment turnover has grown less compared to the group of agrochemicals, thus decreasing its share over the total

* ST stands for seed treatment.

** Rest includes acaricides, anti-scalding products, adjuvants, crustacides, defoliantes, plant growth regulators, fungicides, herbicides, inoculants.

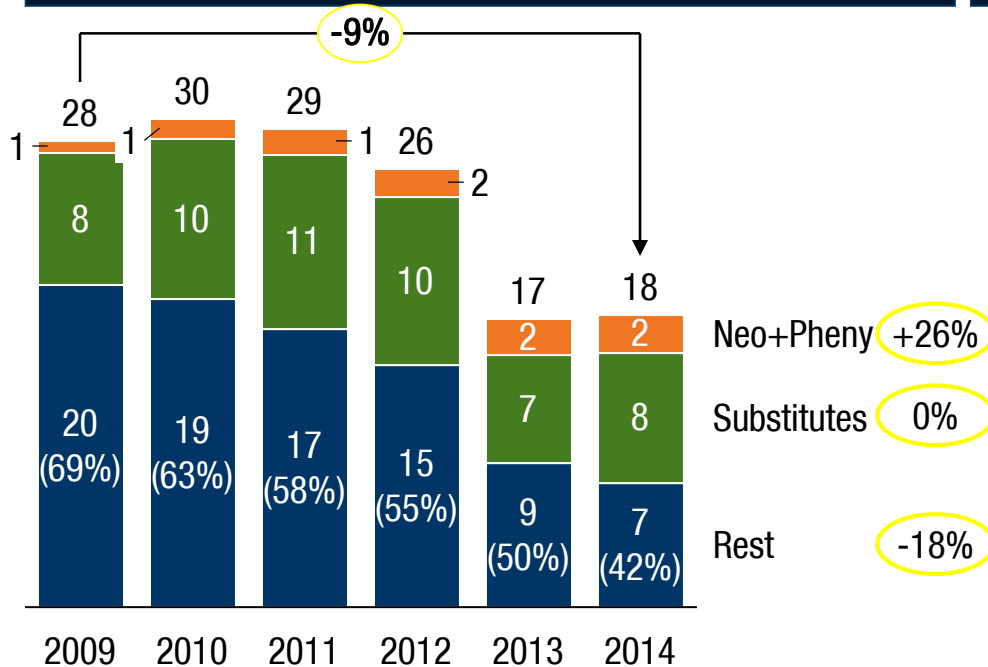
Source: Sebastián Senesi et al, Head of Departamento de Instituciones, Organizaciones y Estrategia - FAUBA based on datasets by Pampas Group.

In foliar insecticides, neonicotinoids and phenylpyrazoles have improved their competitive positioning

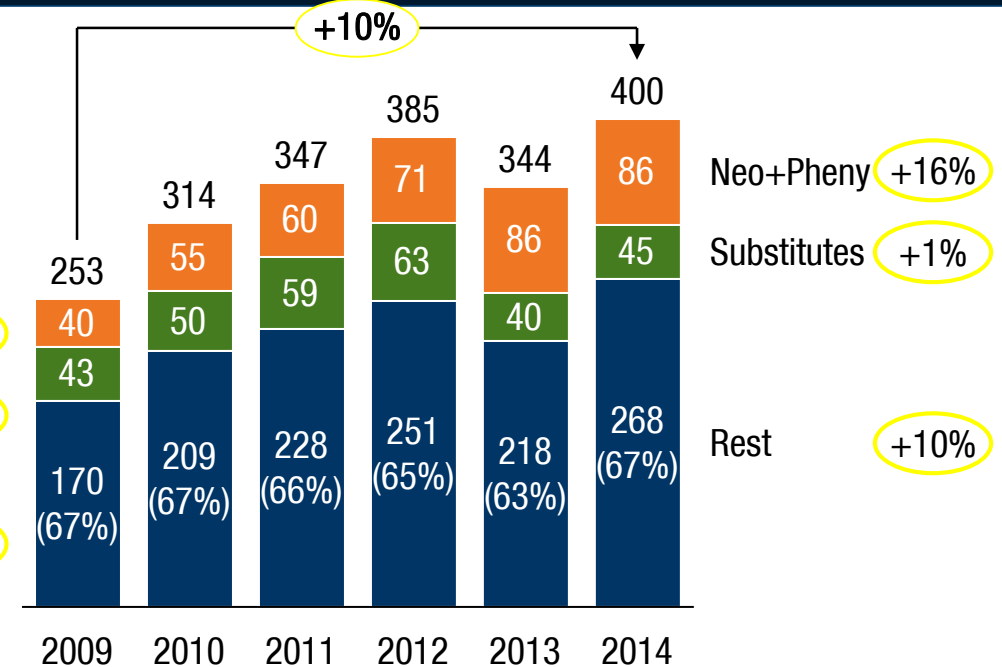
Consumption in millions of liters, Turnover in millions of USD.

CAGR

Insecticide consumption in liters



Insecticide turnover



- In the segment of foliar application **neonicotinoids and phenylpyrazoles** have increased their share both in consumption and turnover...
- ... while turnover and consumptions of their **substitutes** have remained stagnant
- The **rest** of the insecticides has **grown** in turnover with the help of **diamides**

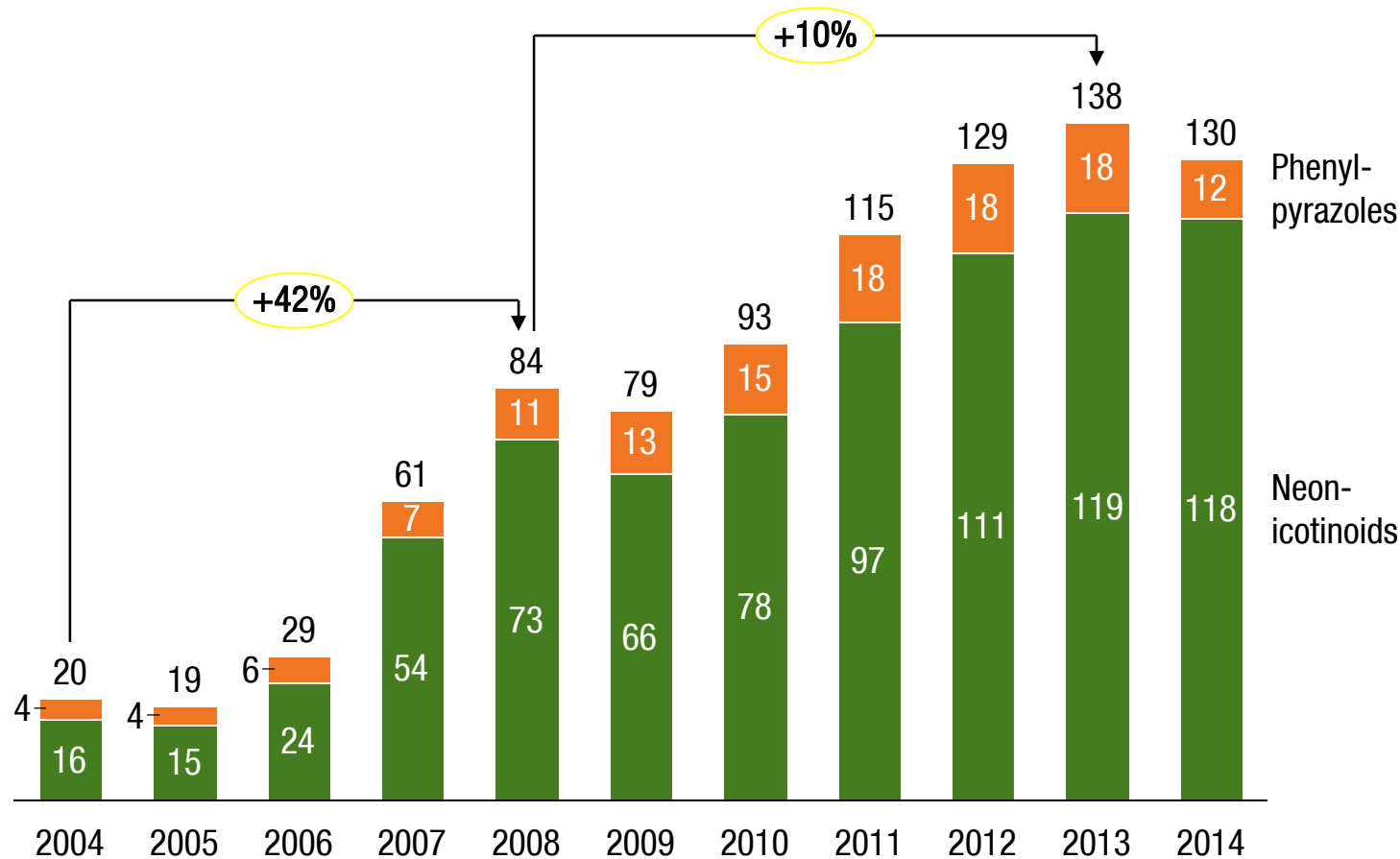
Source: Sebastián Senesi et al, Head of Departamento de Instituciones, Organizaciones y Estrategia - FAUBA based on datasets by Pampas Group.

The increase in the use of insecticides in ST has been the result of the implementation of neonicotinoids and phenylpyrazoles

Millions of USD.

CAGR

Turnover of foliar and seed treatments (ST) containing neonics / phenyl



- The average annual growth of the combined turnover is 20%, which...
- ... is almost the double of the average annual growth of the rest of the agrochemicals in the same period
- Neonicotinoids grow faster in volume terms than in value terms, while ...
- ... phenylpyrazoles grow faster in value terms than in volume terms

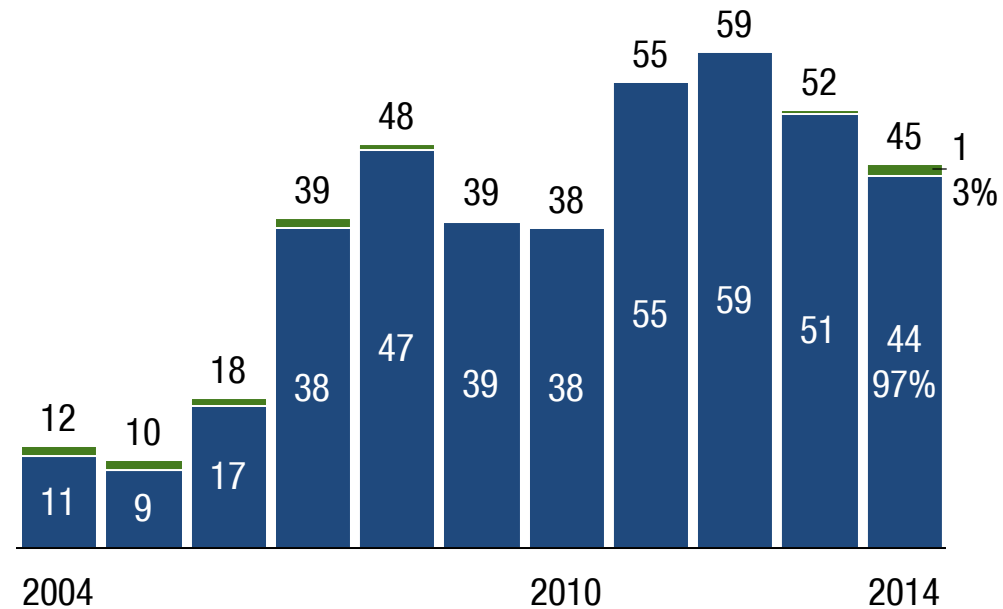
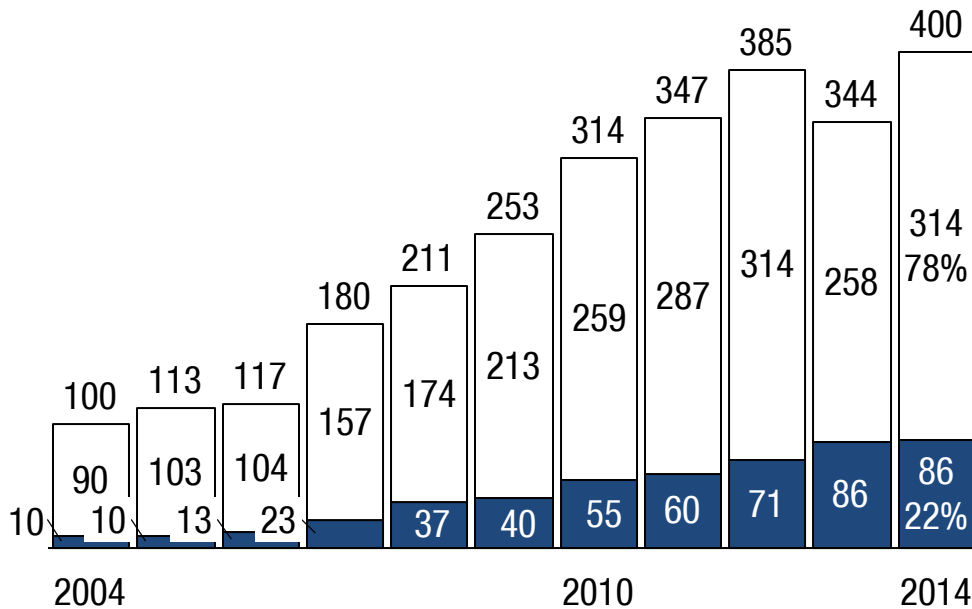
Neonicotinoids and phenylpyrazoles comprise 22% of the turnover regarding insecticides segment and 97% of the ST segment

Millions of USD.

Insecticides
 ST
 ST with Neonics+Feni

Market evolution of the of foliar insecticides

Market evolution of the ST with insecticides



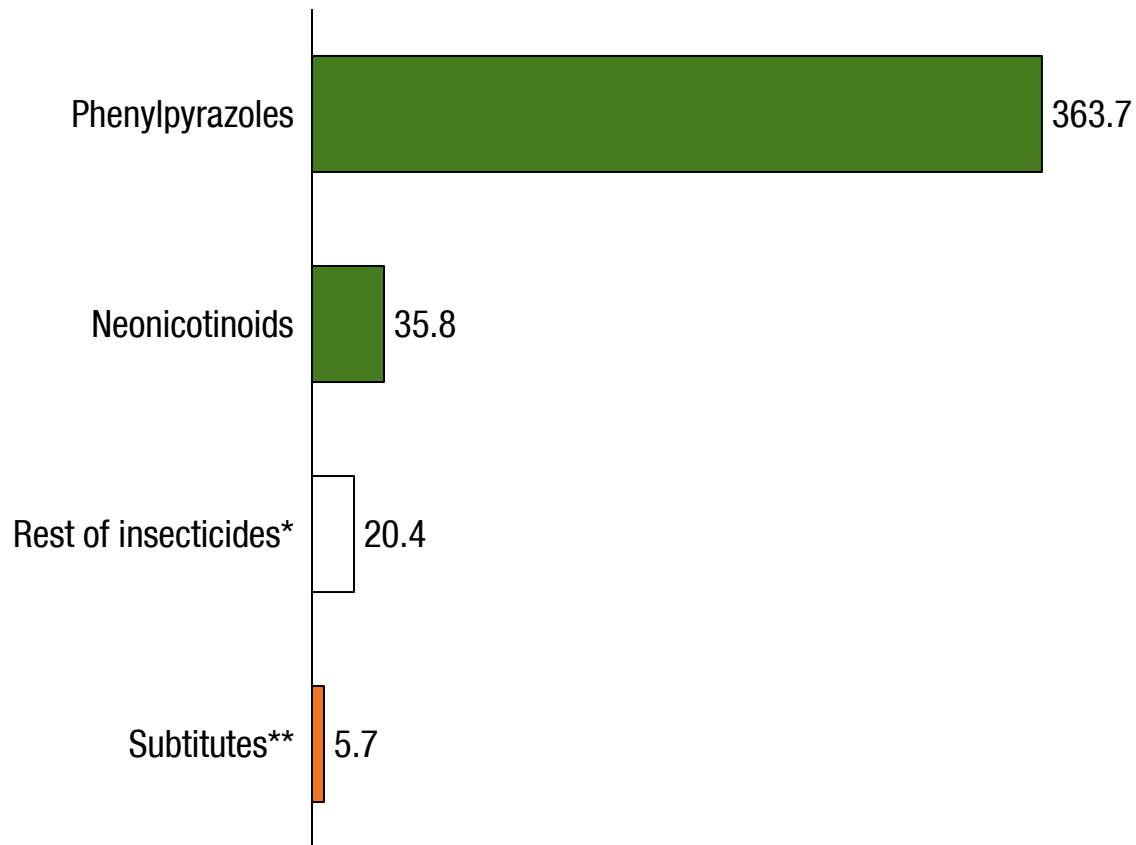
- In both segments, the growth of products with neonicotinoids and phenylpyrazoles is higher than the global growth
- The seed treatments which use neonicotinoids and phenylpyrazoles have captured almost all the market of seed treatments with insecticides
- The insecticides which use neonicotinoids and phenylpyrazoles have gained share in the last decade, and have consequently captured 22% of the market

Source: Sebastián Senesi et al, Head of Departamento de Instituciones, Organizaciones y Estrategia - FAUBA based on datasets by Pampas Group.

The foliar insecticides containing neonicotinoids and phenylpyrazoles are products of higher value / liter

2014, USD/liter.

Average value of insecticides of foliar application classified by type



- The **higher value/liter** is a clear indicator of the **knowledge and technology levels** incorporated in the product
- The average value of the insecticides with **neonicotinoids** is **57% higher** than the average value of the rest of the insecticides
- The average value of the insecticides with **phenylpyrazoles** is **17 times higher** than the average of the insecticides

* Rest includes cypermethrin and its mixtures, chlorpyrifos and its mixtures, diamides, etc.

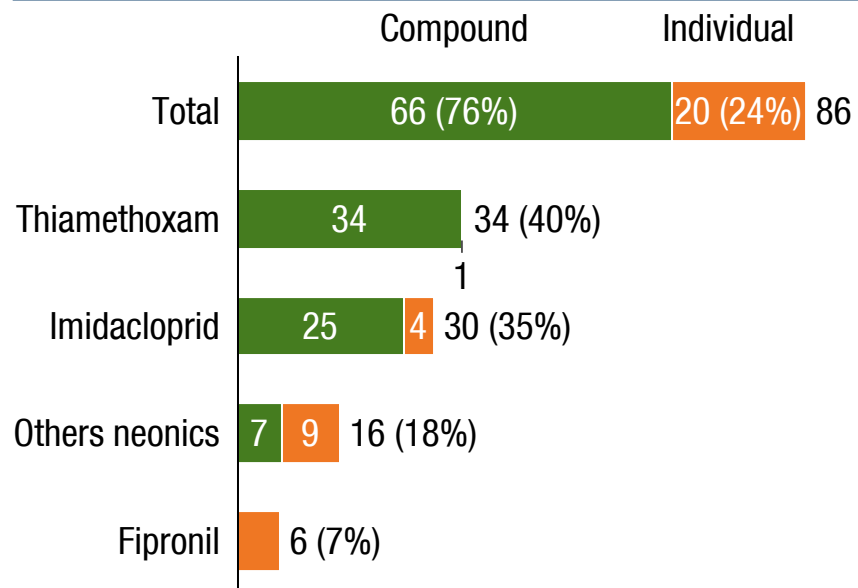
** Substitutes include chlorpyrifos and its mixtures.

Source: Sebastián Senesi et al, Head of Departamento de Instituciones, Organizaciones y Estrategia - FAUBA based on datasets by Pampas Group.

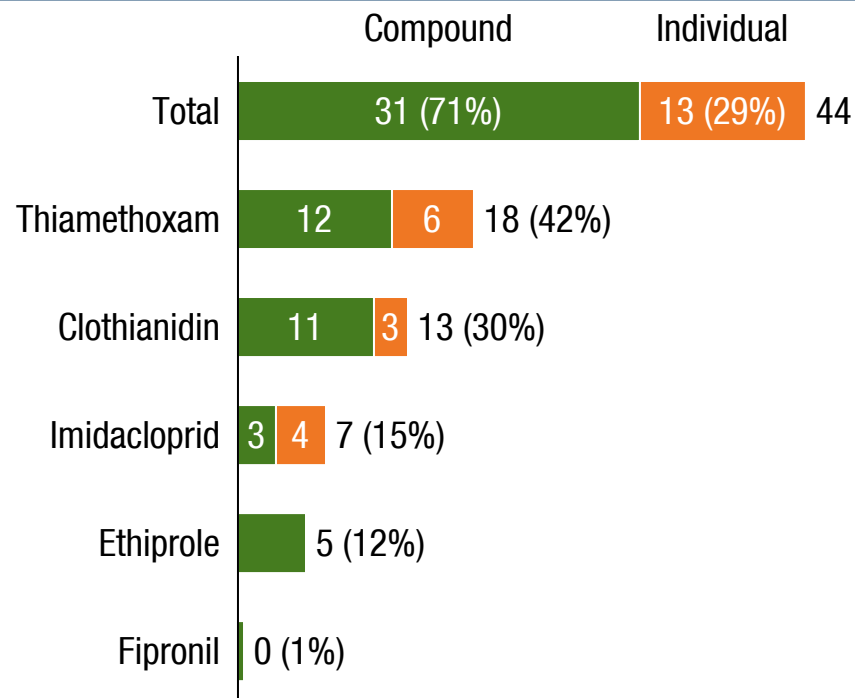
Few molecules represent a great part of the markets of products containing neonicotinoids and phenylpyrazoles

Millions of USD.

Turnover of neonic / phenyl molecules of foliar application



Turnover of neonic / phenyl molecules in ST



- The **Thiamethoxam** is the most popular molecule in use regardless of its application method
- Most of the **neonicotinoids** are applied combined with other molecules for various uses
- The mixtures with **Thiametoxam** and **Imidaclopril** amount to **75%** of the share of neonicotinoids and phenylpyrazoles in foliar applications
- **Thiamethoxam** and **clothianidin** represent **72%** of the total turnover of the seed treatment segment

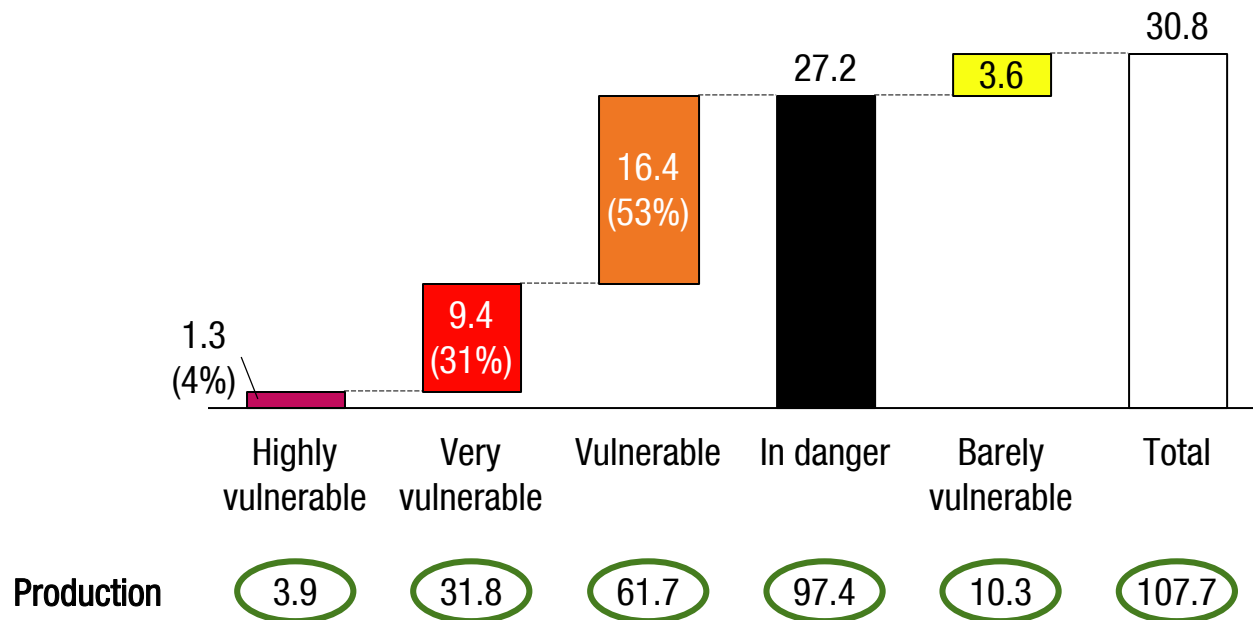
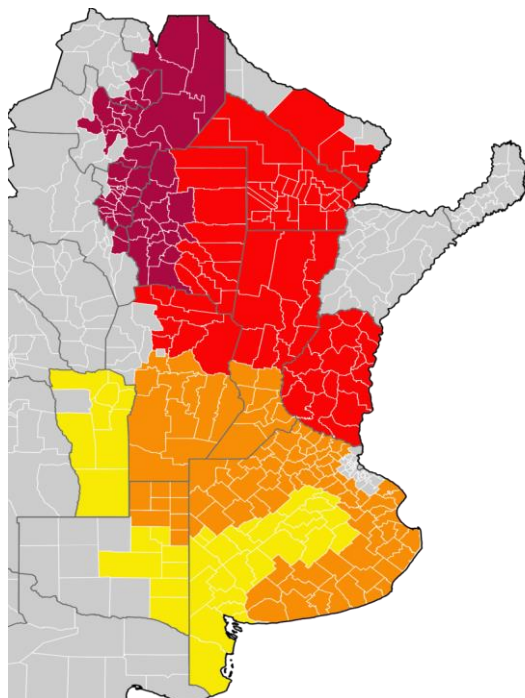
Source: Sebastián Senesi et al, Head of Departamento de Instituciones, Organizaciones y Estrategia - FAUBA based on datasets by Pampas Group.

88% of the agriculture area is positioned in a level ranging from vulnerable to highly vulnerable to insect attack which is equal to 97.4 million tons.

Campaign 2014/2015, Millions of hectares, Millions of tons.

Geolocalización de las zonas más vulnerables

Area cultivable argentina de acuerdo a su nivel de vulnerabilidad



- The **northern area** of the country shows the **highest level of vulnerability**
- The **central area of the country**, including the core and the highest production volume of grains, shows a **certain level of vulnerability**
- The **western area** shows a **lower pre-eminence of insects** which can be fought with neonicotinoids

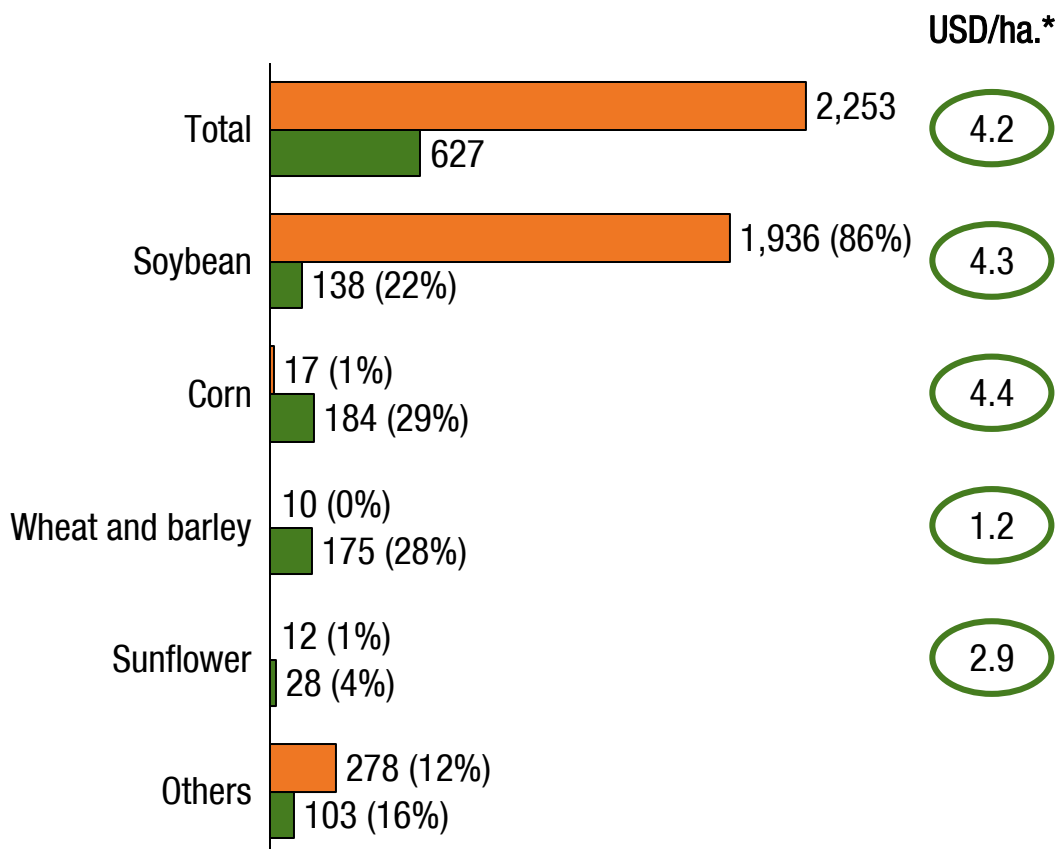
Source: Sebastián Senesi et al, Head of Departamento de Instituciones, Organizaciones y Estrategia - FAUBA based on Panorama Agrícola Semanal (PAS), Bolsa de Cereales de Buenos Aires.

Soybean would suffer the highest economic impact in a ban scenario due to its extension and location in more vulnerable areas

Campaign 2014/2015, Consumption in thousands of liters, Turnover per crop in USD/ha.

■ Foliar
 ■ Seed treatment

Neonicotinoids / phenylpyrazoles consumption per crop



- **Soybean is the main crop for insecticide consumption** based on neonicotinoids / phenylpyrazoles due to:
 - Extension of its area
 - Its geographical distribution which includes the highest vulnerability areas
- **Corn is the leader in seed treatment insecticide consumption** since all the seed is sold in a certified way and “ready to use” with a treatment
- In winter crops the use is mainly linked to seed treatment
- Sunflower consumption is low due to:
 - Its small extension
 - Its geographical location is related to low vulnerability areas

* Result of dividing total consumption by total area.

Source: Sebastián Senesi et al, Head of Departamento de Instituciones, Organizaciones y Estrategia - FAUBA based on datasets by Pampas Group.

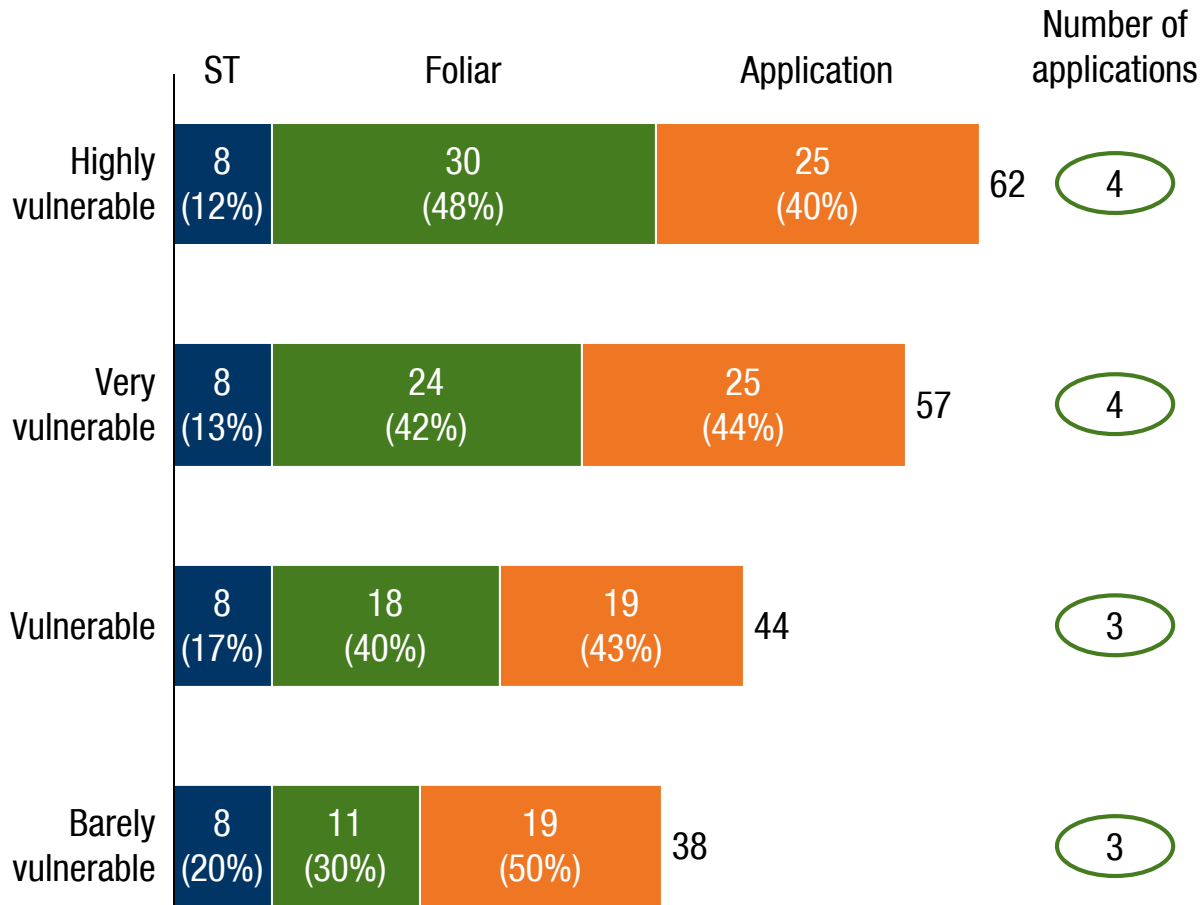
Content

- Strategic importance in the Argentine agriculture
- **Farmer's benefits related to the soybean crop**
- Social and economic impact of technology

There are currently different insect control models according to the vulnerability area

2015/16*, USD per hectare.

Total cost of insect control treatment according to vulnerability

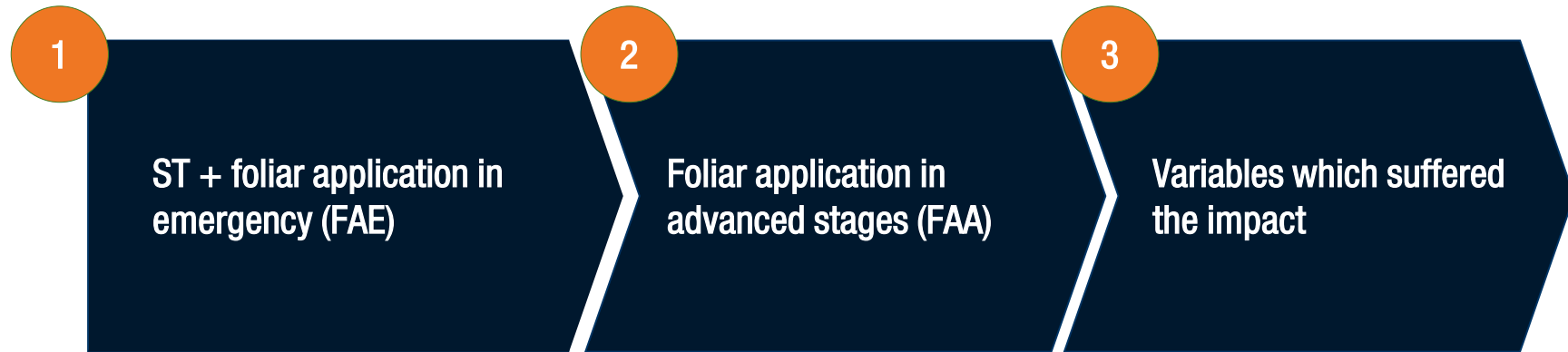


- Application is the main cost in almost all cases
- The lower the vulnerability, the less important the foliar application (FA)
- The seed treatment (ST) is an essential condition for the control of certain insects
- The treatments involve:
 - **Highly vulnerable** (liters/ ha): 0.24 ST with neonic; 0.37 pyrethroid; 0.12 Methoxyfenozide; 0.6 chlorpyrifos; 0.75 neonic FA
 - **Very vulnerable** (liters / ha): 0.24 ST with neonic; 0.26 pyrethroid; 0.12 methoxyfenozide; 0.6 chlorpyrifos; 0.75 neonic FA
 - **Vulnerable** (liters / ha): 0.24 ST with neonic; 0.13 pyrethroid; 0.12 methoxyfenozide; 0.75 neonic FA
 - **Barely vulnerable** (liters / ha): 0.13 pyrethroid; 0.12 methoxyfenozide; 0.25 neonic FA

* Agrochemicals and applications prices based on Márgenes Agropecuarios of February 2016.

Source: Sebastián Senesi et al, Head of Departamento de Instituciones, Organizaciones y Estrategia - FAUBA based on interviews with experts on the market.

Potential combinations of treatment have been defined and together with their impact they result in...

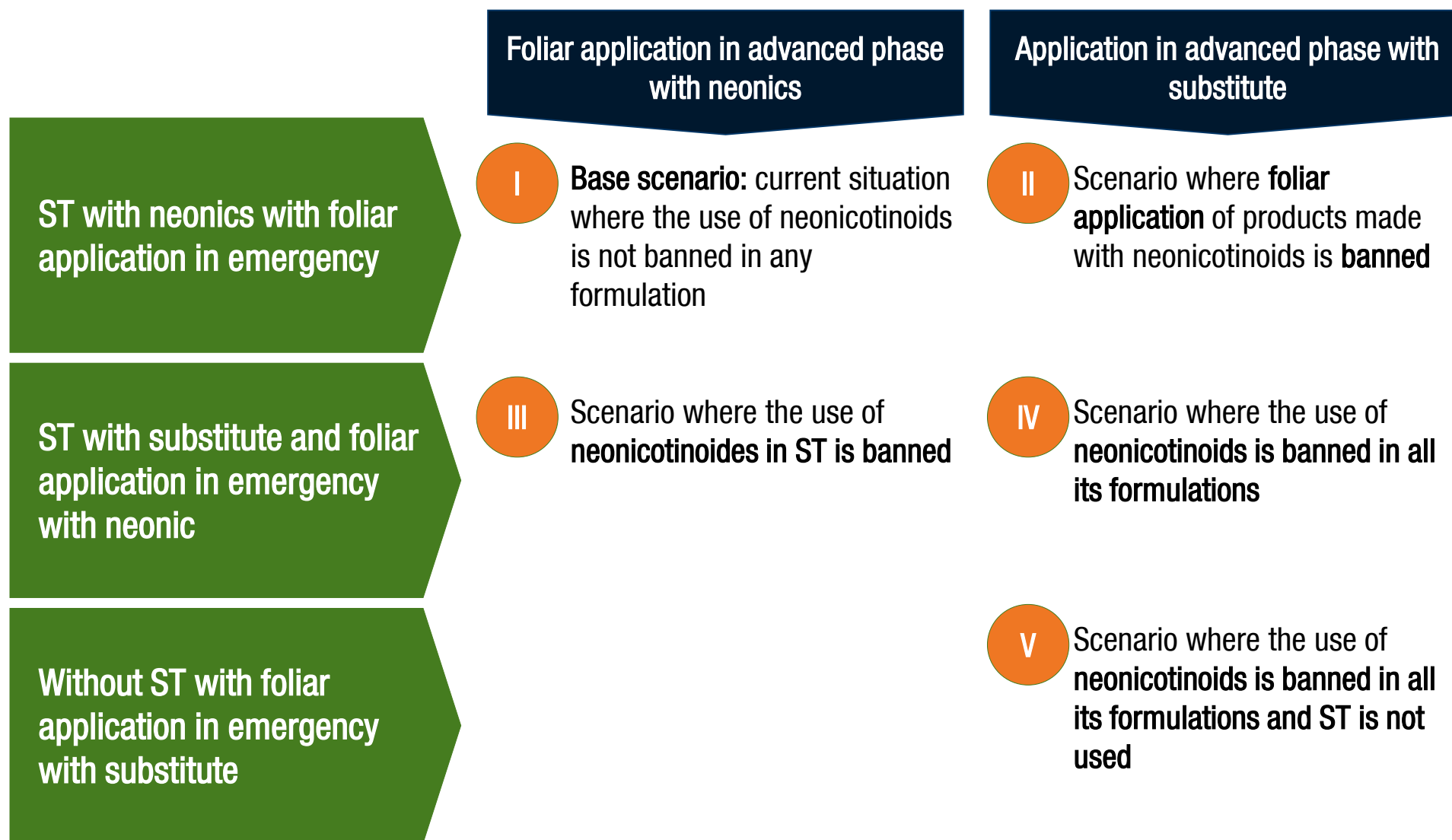


- ST together with foliar applications in emergency prevents the plant from dying in vulnerable areas
- These applications are specific and so applied in the moment the pest appears
- **Income:** potential decline in yields is studied
- **Cost:** differential cost due to a greater number of applications is analyzed
- **Diesel:** more use of diesel due to a greater number of applications is analyzed

Note: ST: Seed treatment. FAE: Foliar application in emergency. FAA: Foliar application in advanced stages. TL – TV: Treatments 1 to 5.

Source: Sebastián Senesi et al, Head of Departamento de Instituciones, Organizaciones y Estrategia - FAUBA.

...5 models of evaluated treatments which represent what happens in the plot



The weighted increase of costs in the different areas between treatment I and treatment IV is 54% ...

2014/15, USD per hectare.

I No ban

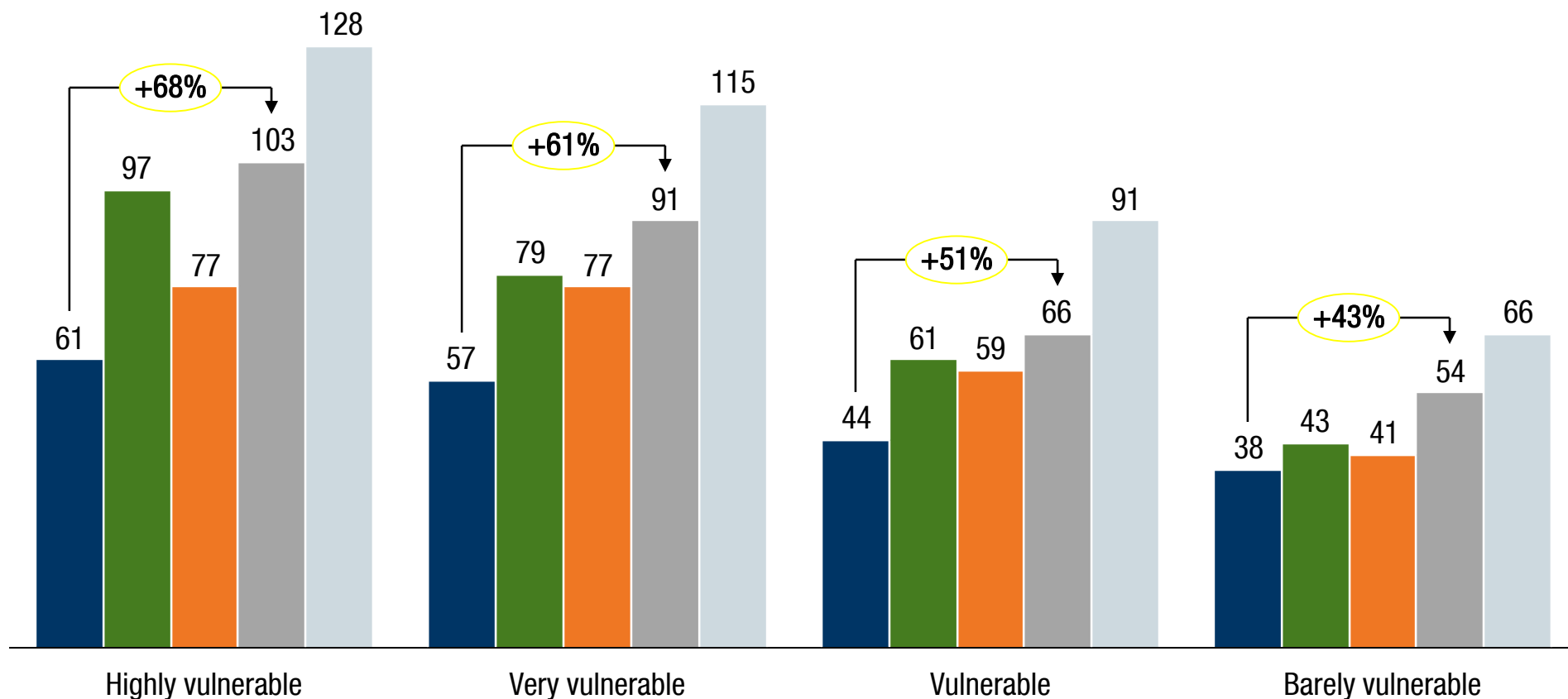
II Foliar ban

III ST ban

IV Total ban

V Total ban without ST

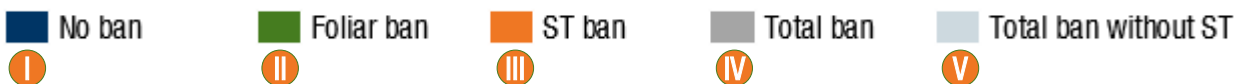
Cost of treatment against insect by vulnerability area



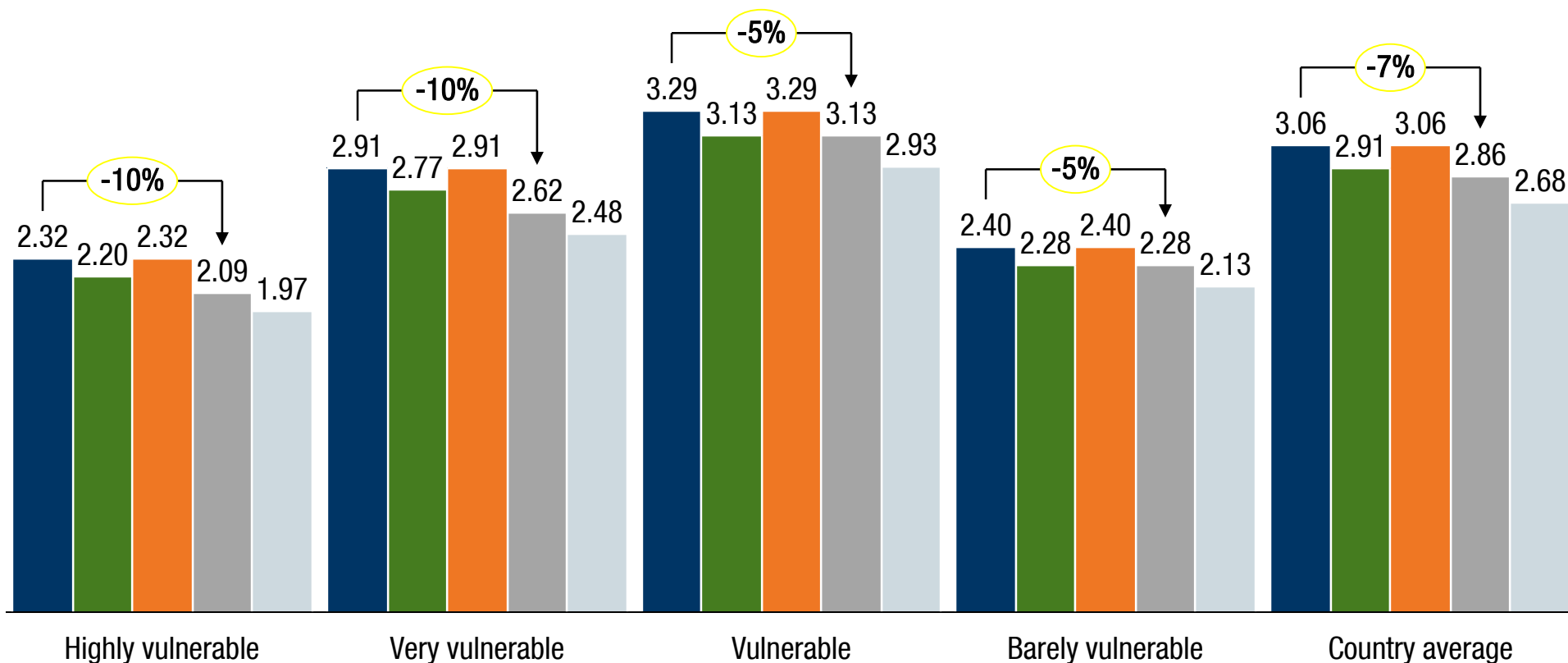
Source: Sebastián Senesi et al, Head of Departamento de Instituciones, Organizaciones y Estrategia - FAUBA based on interviews with experts on the market.

... which also determines falls in yield of 7% ...

2014/15, USD per hectare.



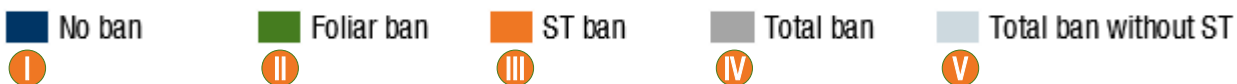
Yield decline per hectare by vulnerability area



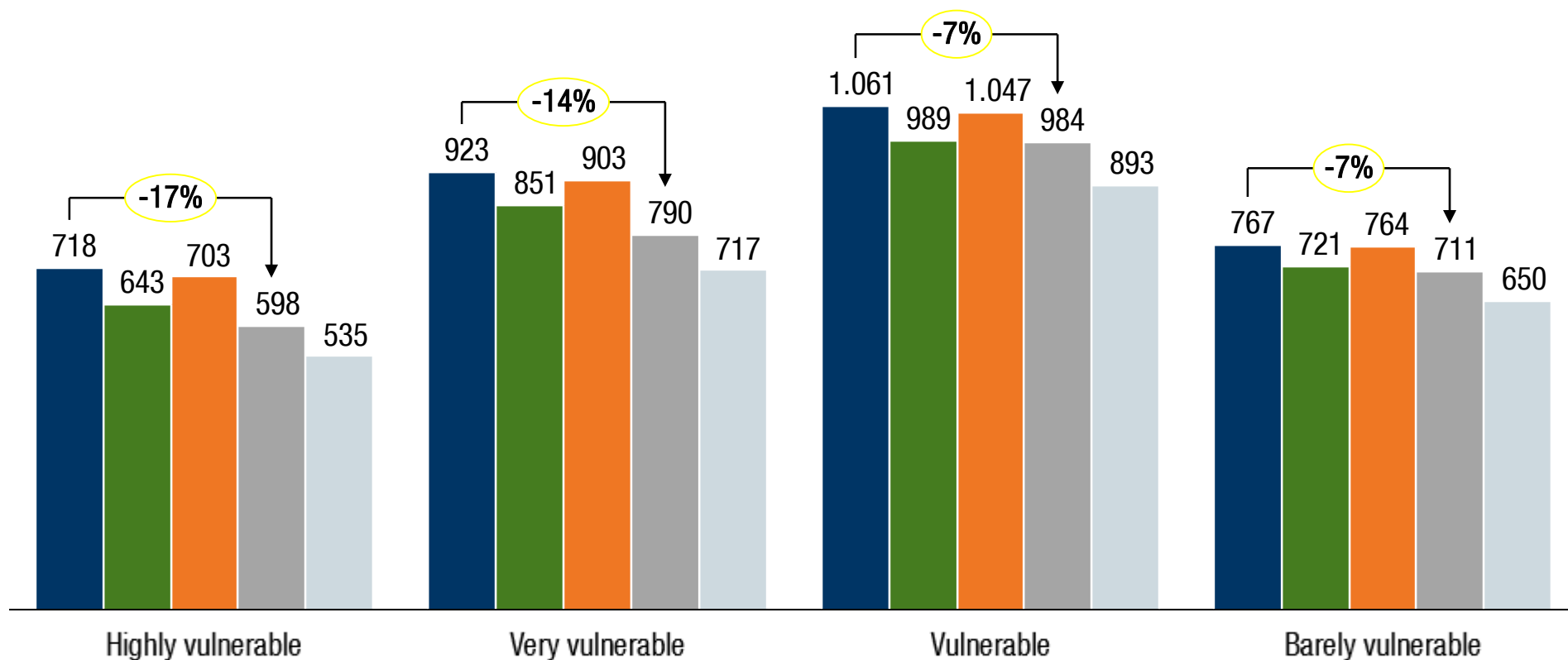
Source: Sebastián Senesi et al, Head of Departamento de Instituciones, Organizaciones y Estrategia - FAUBA FAUBA based on "la importancia de saber proteger oportunamente las hojas del cultivo de soja" by Perotti and Gamundi (INTA Oliveros), "The effectiveness of neonicotinoids in seed treatments in soybean", manual of Purdue University, Caracterización de daños de chinches en soja y criterios para la toma de decisiones de manejo", Gamundi and Sosa (INTA Manfredi), "Do neonicotinoid seed treatments have value regionally in soybeans?" by Angus Catchot (Mississippi State University) and historical performances published by Panorama Agrícola Semanal of Bolsa de Cereales de Buenos Aires.

... which also determines a weighted fall of incomes having deducted the insect control by 10%

2014/15, USD per hectare.



Crop revenue net of insects treatment by vulnerability area



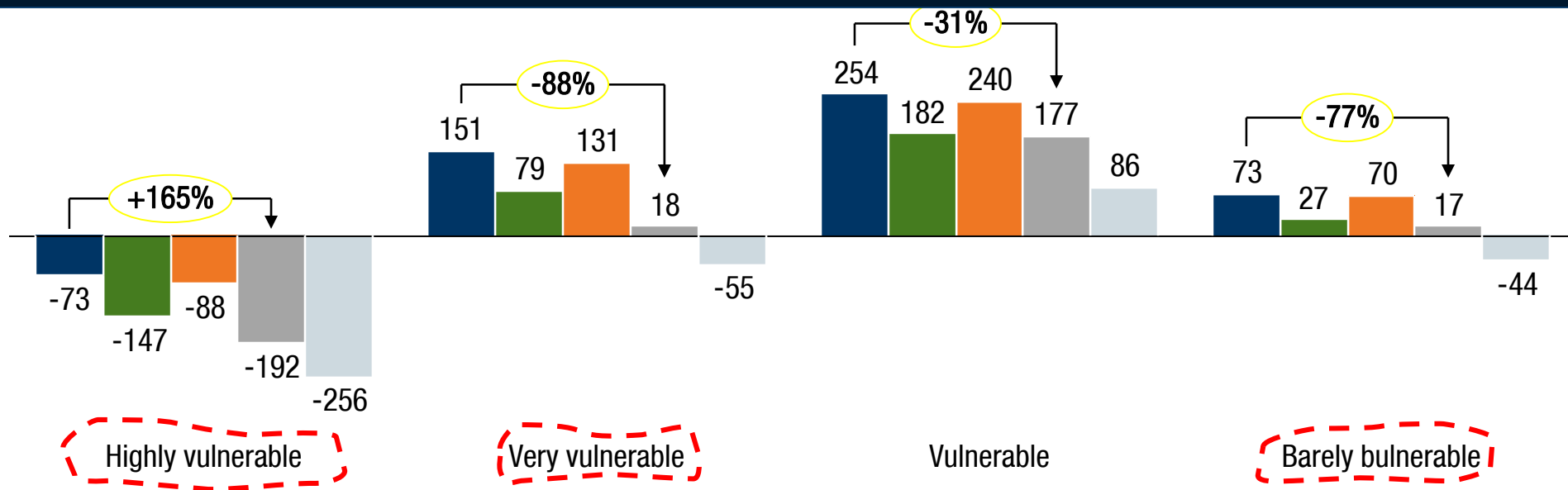
Source: Sebastián Senesi et al, Head of Departamento de Instituciones, Organizaciones y Estrategia - FAUBA based on interviews to experts on the market, "la importancia de saber proteger oportunamente las hojas del cultivo de soja" by Perotti and Gamundi (INTA Oliveros), "The effectiveness of neonicotinoids in seed treatments in soybean", manual of Purdue University, Caracterización de daños de chinches en soja y criterios para la toma de decisiones de manejo", Gamundi and Sosa (INTA Manfredi), "Do neonicotinoid seed treatments have value regionally in soybeans?" by Angus Catchot (Mississippi State University) and historical performances published by PAS of Bolsa de Cereales de Buenos Aires.

The rise in costs combined with a fall in incomes determines some areas where the soybean crop becomes unfeasible

2014/15, USD per hectare in own field.

Unfeasible areas (red dashed box) I No ban II Foliar ban III ST ban IV Total ban V Total ban without ST

Gross margin by vulnerability area



- Profitability is affected by **average low yield** and **distance to port**
- It would be **economically unfeasible** in any scenario of neonicotinoids ban

- It **acceptably tolerates the ban** of foliar insecticides with neonicotinoids, while ...
- ... **total ban would turn it economically unfeasible**

- The **only soybean farmers** of the country with the **possibility of absorbing any kind of ban** ...
- ... to the **risky level of reducing its margin by 31%**

- Profitability is affected by **average low yield** and **distance to port**
- A **foliar or total ban** of neonicotinoids **would turn it economically unfeasible**


Source: Sebastián Senesi et al, Head of Departamento de Instituciones, Organizaciones y Estrategia - FAUBA based on interviews to experts on the market, and historical performances published by PAS of Bolsa de Cereales de Buenos Aires and Márgenes Agropecuarios.

Summary: both neonicotinoids and phenylpyrazoles have become an essential tool for insect control methods

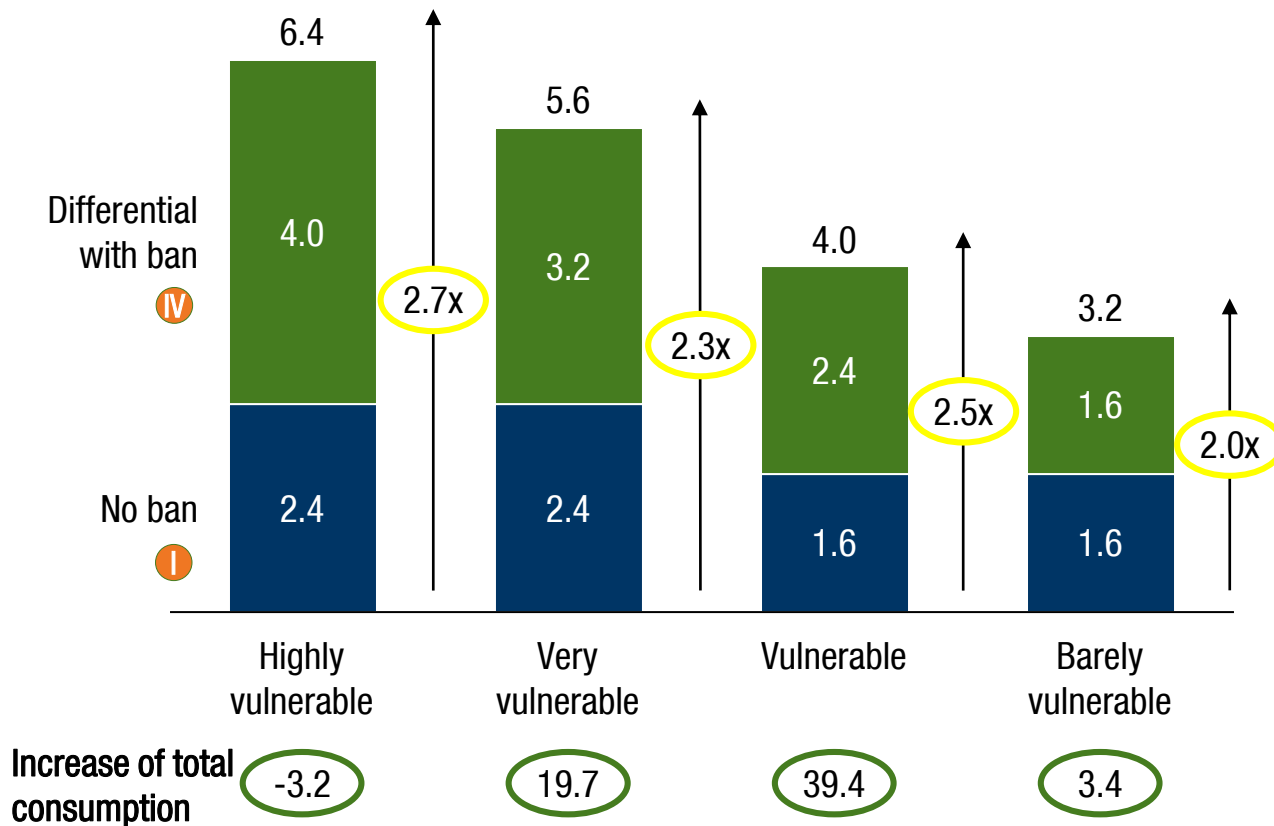
- Both neonicotinoids and phenylpyrazoles are the insecticides which have shown a greater evolution in the last years in either of the application methods (seed treatment or foliar)
- The value/liter of the same is one of the highest among the insecticides, thus they appear to be at the level of the greatest added value of knowledge and technology
- 93% of the soybean area (18.6 million of cultivated hectares) is located in areas which are at least vulnerable to insect attack, which means a ...
- ... production of more than 58 million tons of a total of 61 million
- Technological ban significantly affects the gross margin of the farmer, depending the area of location because ...
- ... the higher the vulnerability level, the higher the impact

Neonics and phenylpyrazoles ban causes double consumption of diesel in applications, thus raising the carbon footprint

2014/15, Liters of diesel per hectare, Millions of liters per vulnerability area.

 Growth between one scenario and another

Diesel consumption scenarios for insect treatment in soybean by vulnerability area



- **Neonicotinoids and phenylpyrazoles ban in seed treatment as well as in foliar application causes an increase of need of foliar applications with the consequent diesel consumption...**
- ... from a weighted average of 2.35 liters in the base scenario to a weighed average of 5.46 liters in the ban scenario with an intermediate loss of area
- **Ban produces an additional consumption of 59 million liters in foliar applications, causing the double of CO2 emissions**

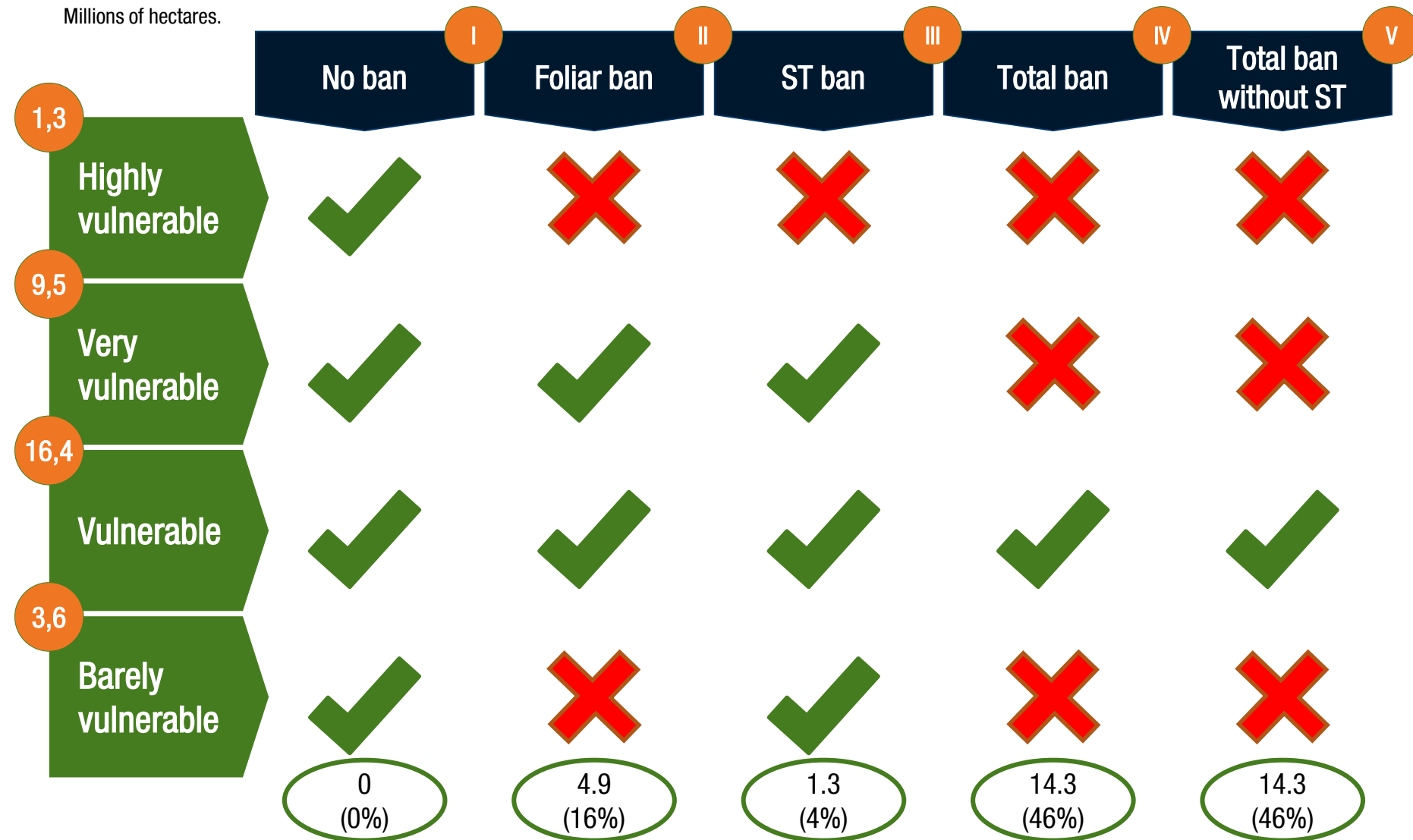
Source: Sebastián Senesi et al, Head of Departamento de Instituciones, Organizaciones y Estrategia - FAUBA based on interviews to experts on the market and area published by PAS of Bolsa de Cereales de Buenos Aires and Márgenes Agropecuarios.

Content

- Strategic importance in the Argentine agriculture
- Farmer's benefits related to the soybean crop
- **Social and economic impact of technology**

In a scenario of total ban of neonicotinoids and phenylpyrazoles, the 46% of the Argentine agriculture area would be compromised

Millions of hectares.



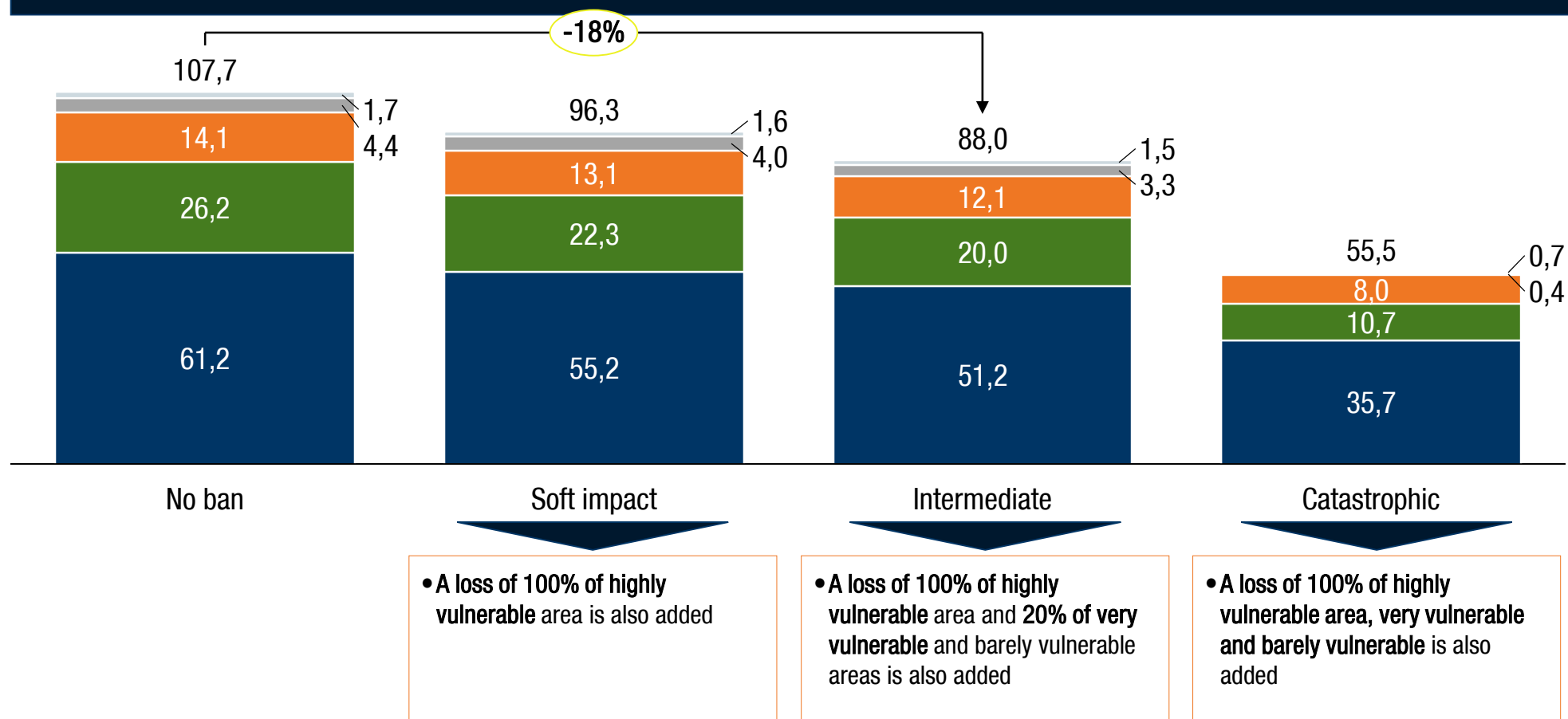
Source: Sebastián Senesi et al, Head of Departamento de Instituciones, Organizaciones y Estrategia - FAUBA.

With a total ban and an intermediate scenario of agricultural area reduction, almost 20 million tons are lost.

Millions of tons.

Sunflower Sorghum Wheat+Barley Corn Soybean

Yield loss in the “total ban” scenario

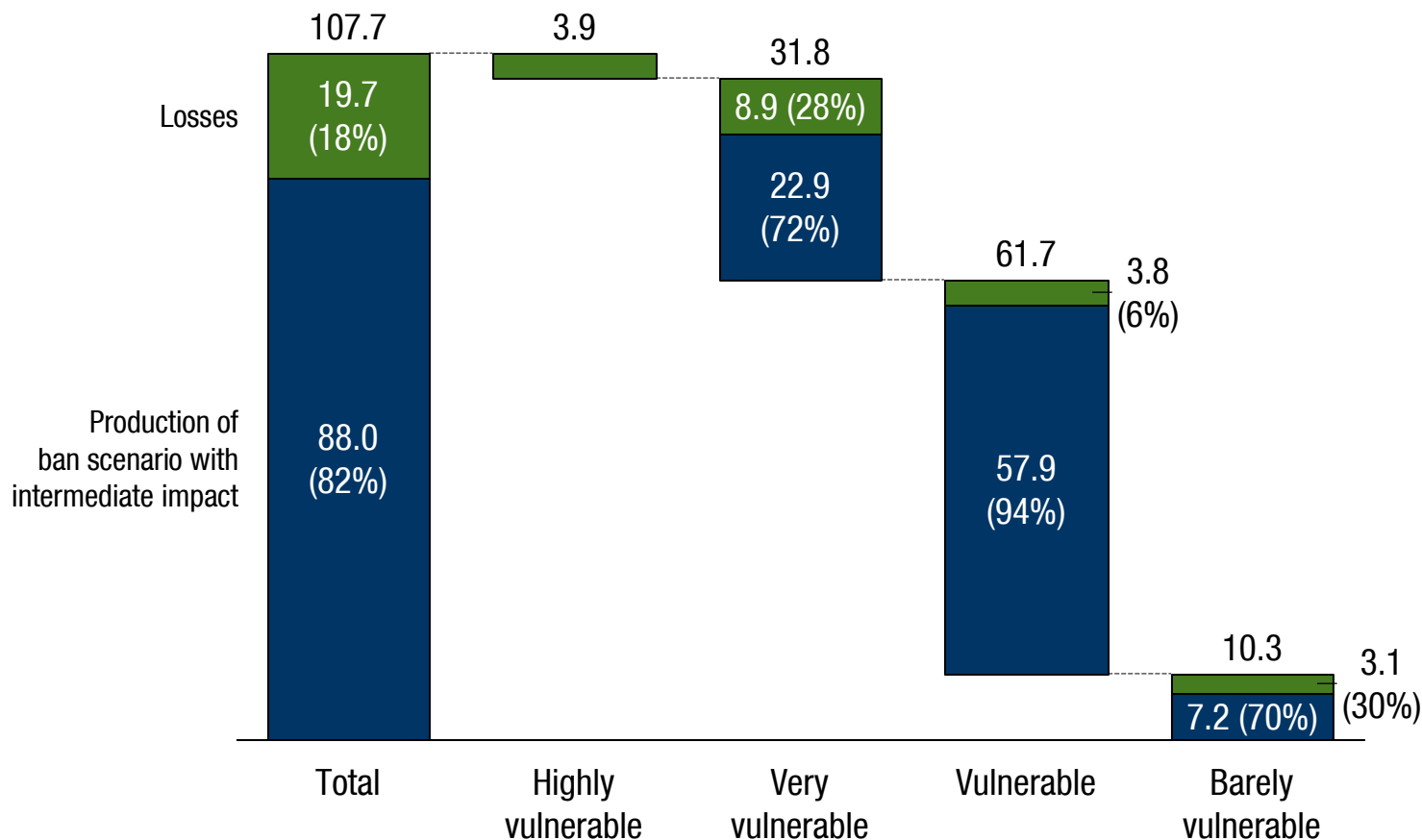


Source: Sebastián Senesi et al, Head of Departamento de Instituciones, Organizaciones y Estrategia - FAUBA based on interviews to experts on the market, and historical performances published by PAS of Bolsa de Cereales de Buenos Aires and Márgenes Agropecuarios

The highly vulnerable area stops production, while the other areas are affected by losses of about 30%

Millions of tons.

Losses due to vulnerability areas in an intermediate impact ban scenario



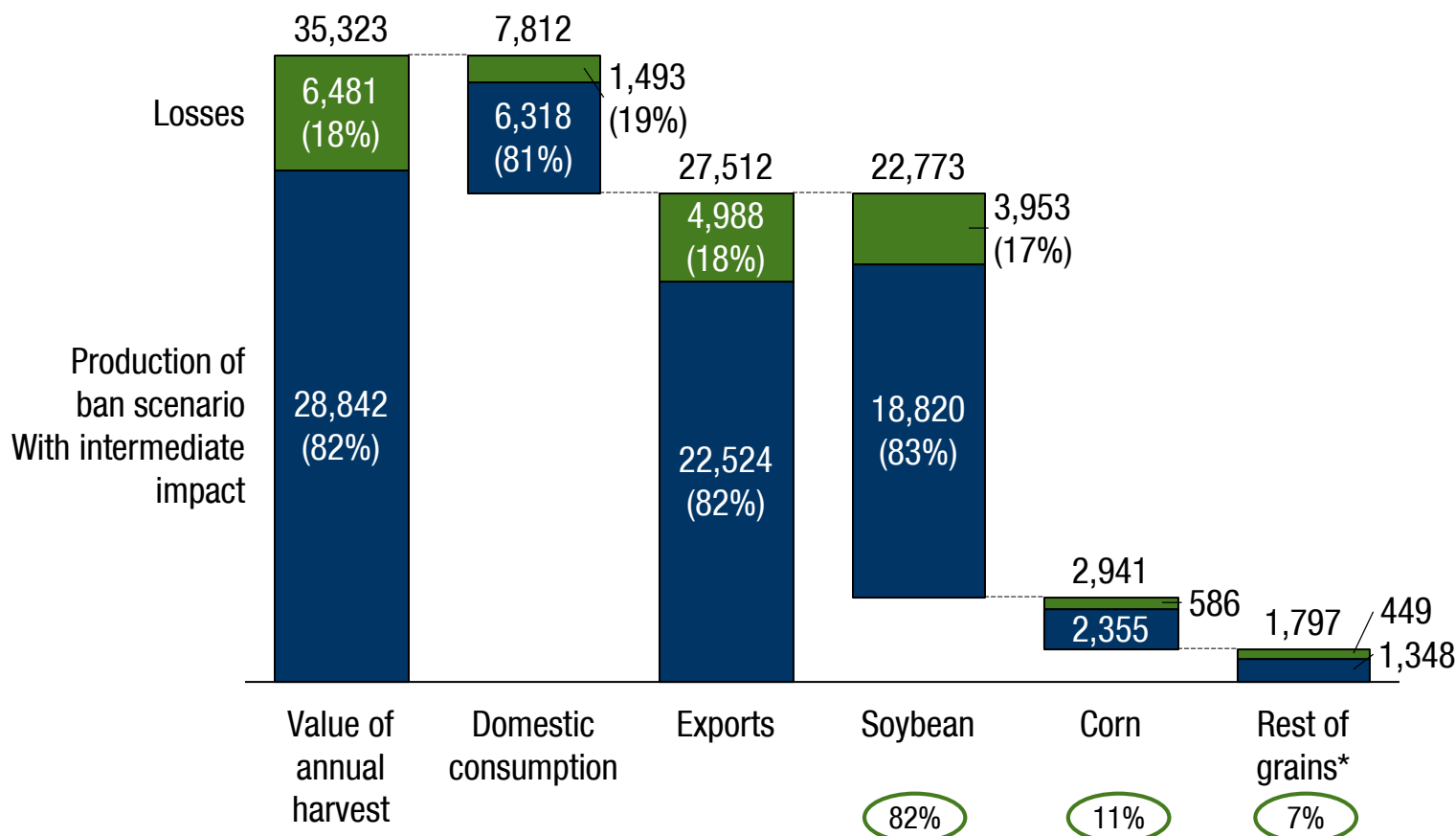
- Neonicotinoids and phenylpyrazoles ban in seed treatment as well as in foliar application causes a loss of 19.7 million tons in the system
- The highly vulnerable area is the most affected zone which loses its whole production and causes a fall of 4% in the total country production
- The Very vulnerable area, which is less affected, causes the greatest impact at national level with a loss of 45%
- The Barely vulnerable area suffers a loss of one third of its production

Ban causes a loss of crop value of USD 6.5 thousand million and a loss of exports of USD 5 thousand million

Millions of USD.

○ Export share

Value of the annual harvest and losses due to ban for destination of production and crop



- **Soybean** is the crop which **covers the largest zone** in all vulnerable areas and ...
- ... causes a **higher production and exports volume**, therefore ...
- ... represents **79% of the fall in exports**
- **The rest of the crops**, which have a **smaller share destined for exports**, cause a greater loss for domestic consumption than exports

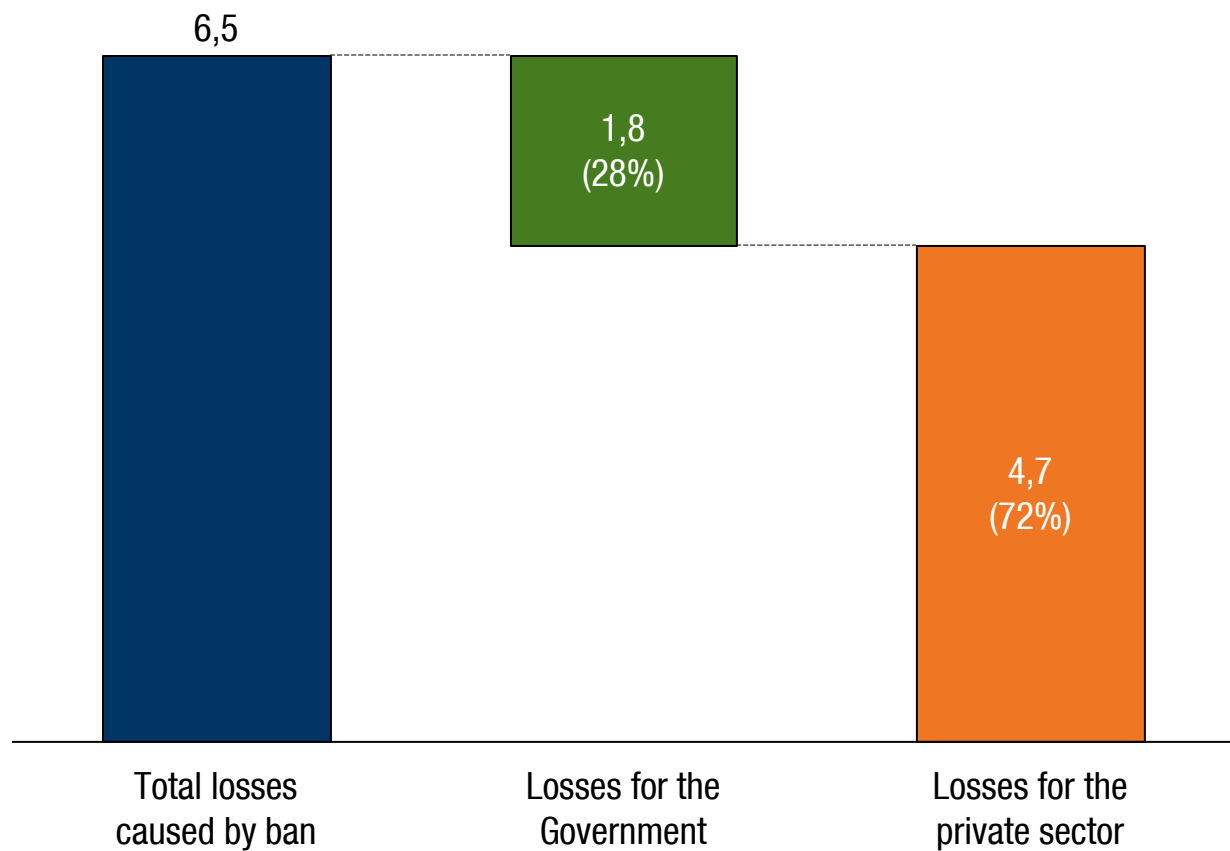
* Rest of the grains include: wheat, barley, sorghum and sunflower.

Source: Sebastián Senesi et al, Head of Departamento de Instituciones, Organizaciones y Estrategia - FAUBA based on FAS-USDA and spot prices April 19, 2016 BCR.

Neonicotinoids and phenylpyrazoles ban causes dramatic losses both for the private sector and for the Government

Billions USD.

Social value for the system of neonicotinoids and phenylpyrazoles ban



- Neonicotinoids and phenylpyrazoles ban both in seed treatments and in foliar applications causes a loss of USD 6.5 thousand billion in the system
- The Government would stop receiving tax revenues for an amount of USD 1.8 billion (28%), while ...
- ... the private sector would suffer losses of USD 4.7 billion (72%)

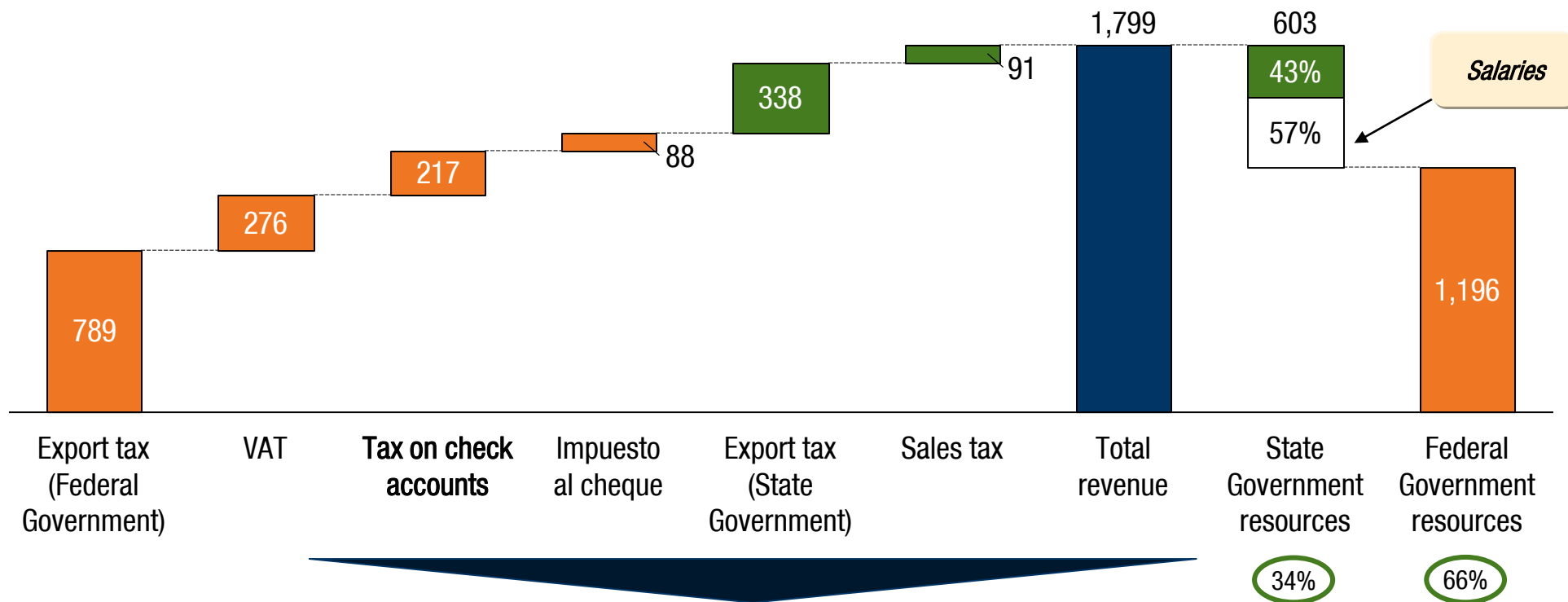
Source: Sebastián Senesi et al, Head of Departamento de Instituciones, Organizaciones y Estrategia - FAUBA based on FAS-USDA and spot prices April 19, 2016 BCR.

The ban causes a loss of resources for the Government of USD 1.8 billion

Millions of USD.

State Government Federal Government

Dynamic of tax collection and expenditure of the Federal and Provincial Governments



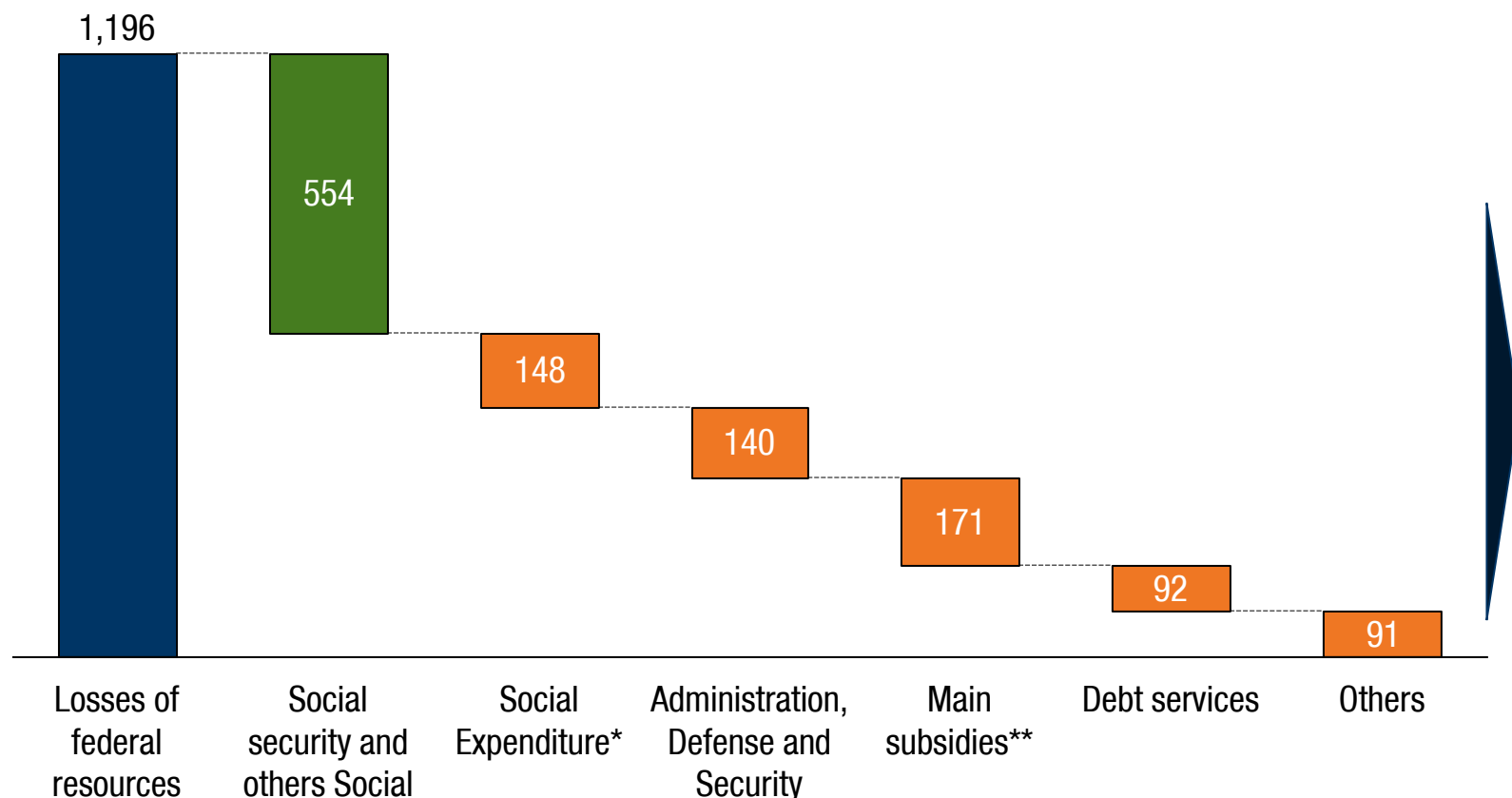
- The Government stops generating federal resources where a certain part is jointly shared, resources automatically distributed to the provinces and resources generated by the provinces
- This volume of resources no longer generated are **distributed among the Federal Government and the State Governments**

Source: Sebastián Senesi et al, Head of Departamento de Instituciones, Organizaciones y Estrategia - FAUBA based on tax legislation and forecasts of the Asociación Argentina de Presupuesto (ASAP).

For the Federal Government, a lower volume of federal resources means fewer public services for the society

Budget 2015, Millions of USD.

Simulation of budget restriction by category



- For instance, the budget reduction simultaneously includes the decrease of sensitive categories of social assistance:
 - The highest expense of the Government is related to the retirement and pension scheme, where the budget reduction is equal to **140 thousand minimum retirement benefits in a year**
 - The impact regarding social expenditure would exceed **51 thousand Universal Allowance per Child (AUH in Spanish) or Family Allowance in one year**

* The main social expenditure involves the teacher incentive fund and the National Universities and the scientific national system (USD 69 million), Health (USD 39 million) and Family Allowance (USD 40 million).

** Subsidies for energy systems (USD 133 million) and subsidies for transportation, mainly the railway system (USD 38 millions).

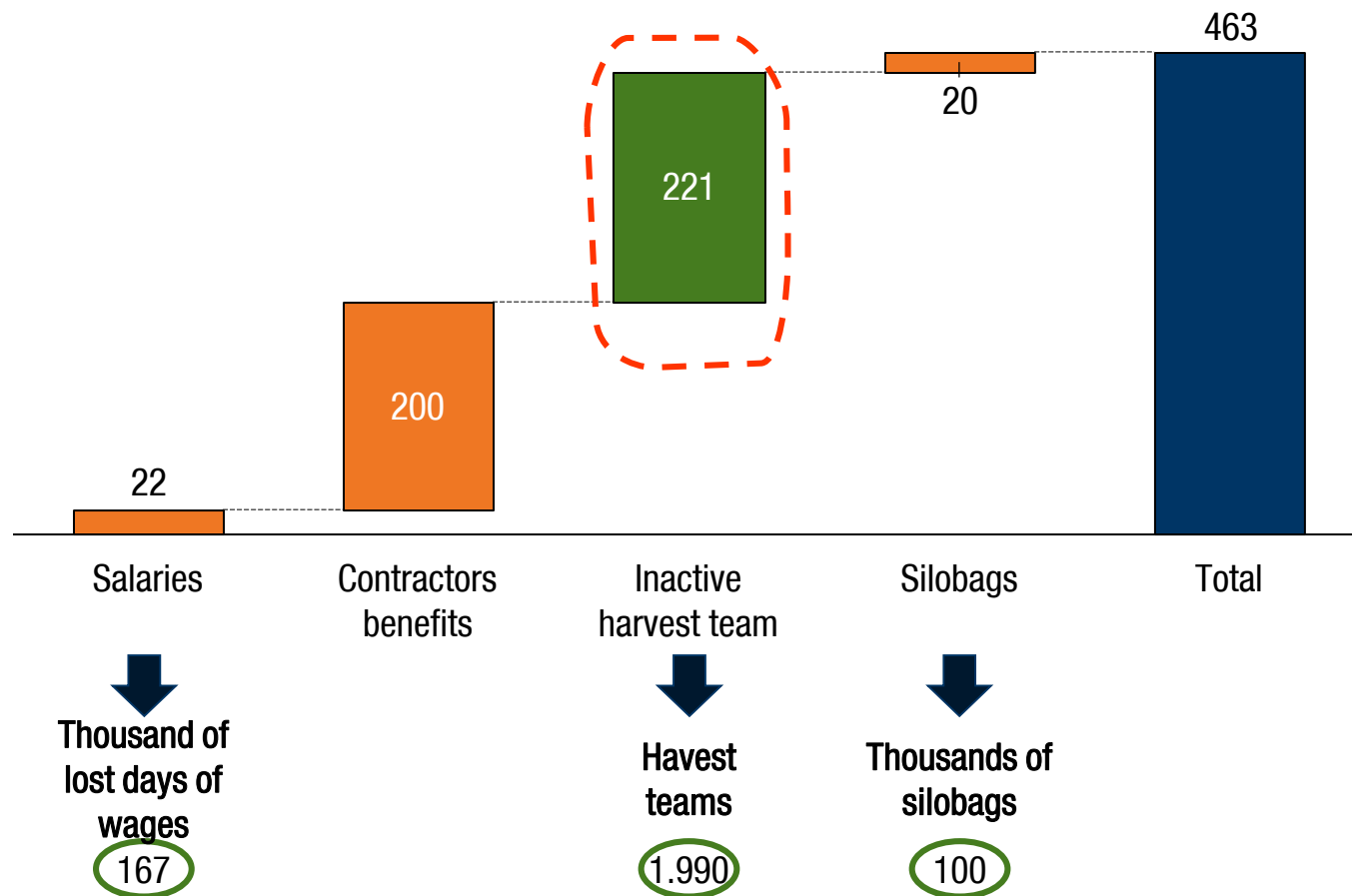
Source: Sebastián Senesi et al, Head of Departamento de Instituciones, Organizaciones y Estrategia - FAUBA FAUBA based on the 2015 Federal Budget.

The harvest node loses economic activity equivalent to USD 463 million caused by ban

Millions of USD.

 Investment in durable goods

Income lost in the harvest caused by neonicotinoids and phenylpyrazoles ban



- The loss of 20 millions tons in the resulting harvest means reductions in:
 - Salaries for farm wage laborers
 - Income for contractors
 - Investment capacity inactive in harvesters and other pieces of equipment
 - Decrease of silo bags consumption

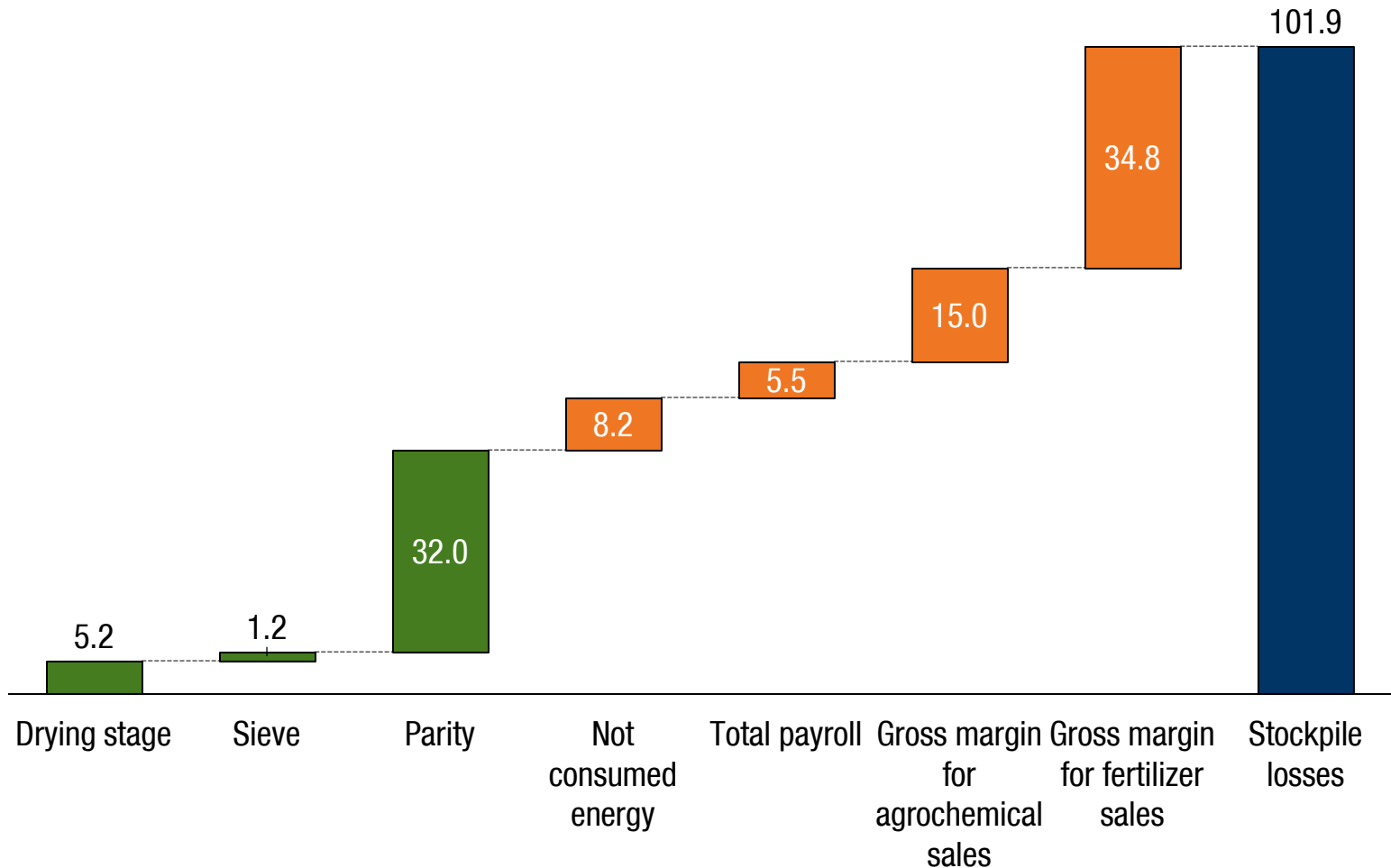
* The harvest equipment consists of: 1 harvest combine, a dump tractor, a booth and a tank truck.

Source: Sebastián Senesi et al, Head of Departamento de Instituciones, Organizaciones y Estrategia – FAUBA.

Ban generates an economic activity loss of USD 102 million in the stockpile stage

Millions of USD.

Income lost in the stockpile segment caused by neonicotinoids and phenylpyrazoles ban



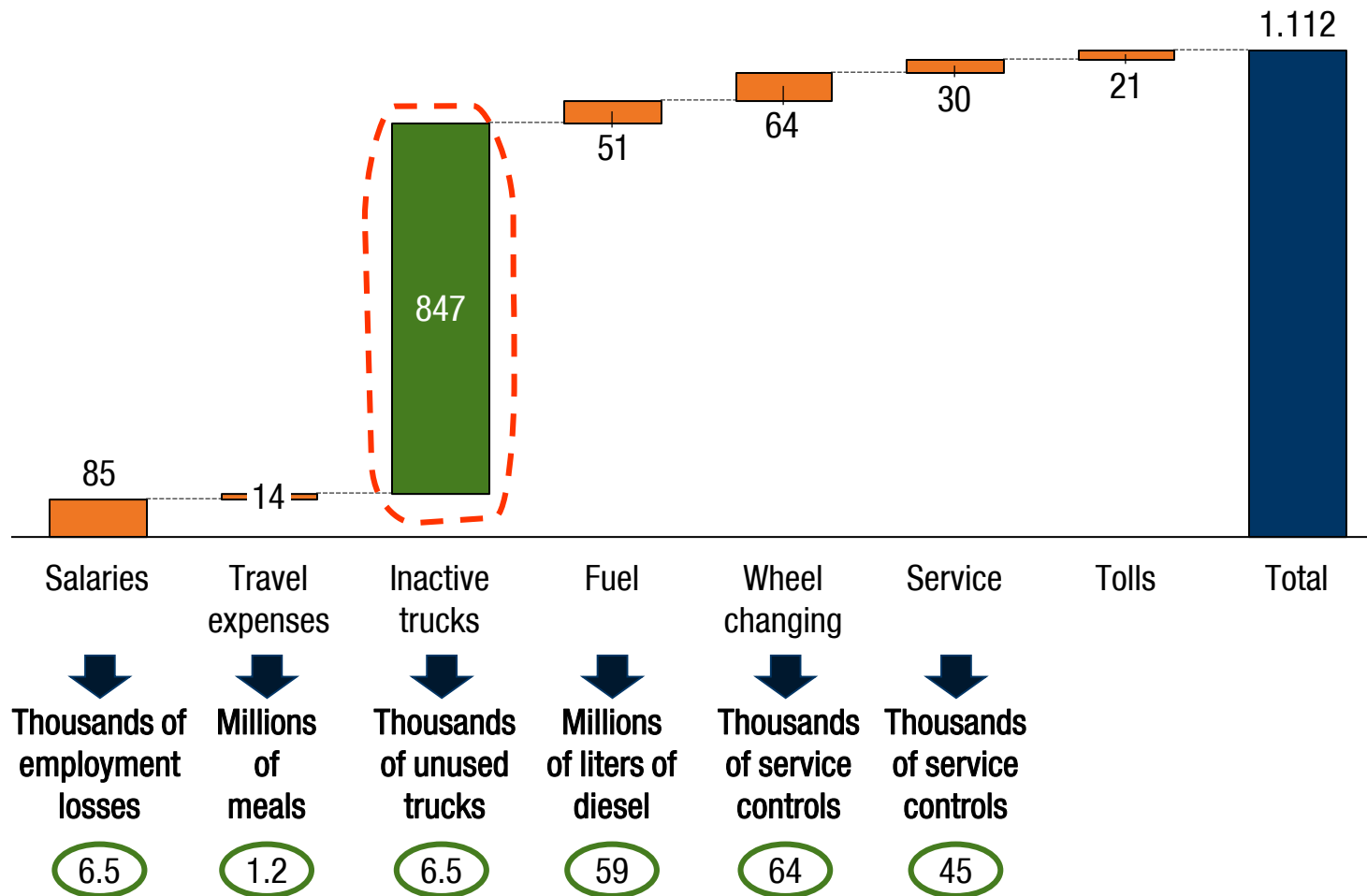
- Harvest reduction means a decrease of 330 thousand wages in stockpiles ...
- ... which represent a total payroll of over 5.5 million dollars
- A network of provision of inputs of great importance due to their presence along the whole country and proximity with the farmer is put at risk

The logistics arena will lose an economic movement of USD 1,112 million caused by ban

Millions of USD.

 Investment in durable goods

Income lost in the logistics due to neonicotinoids and phenylpyrazoles ban



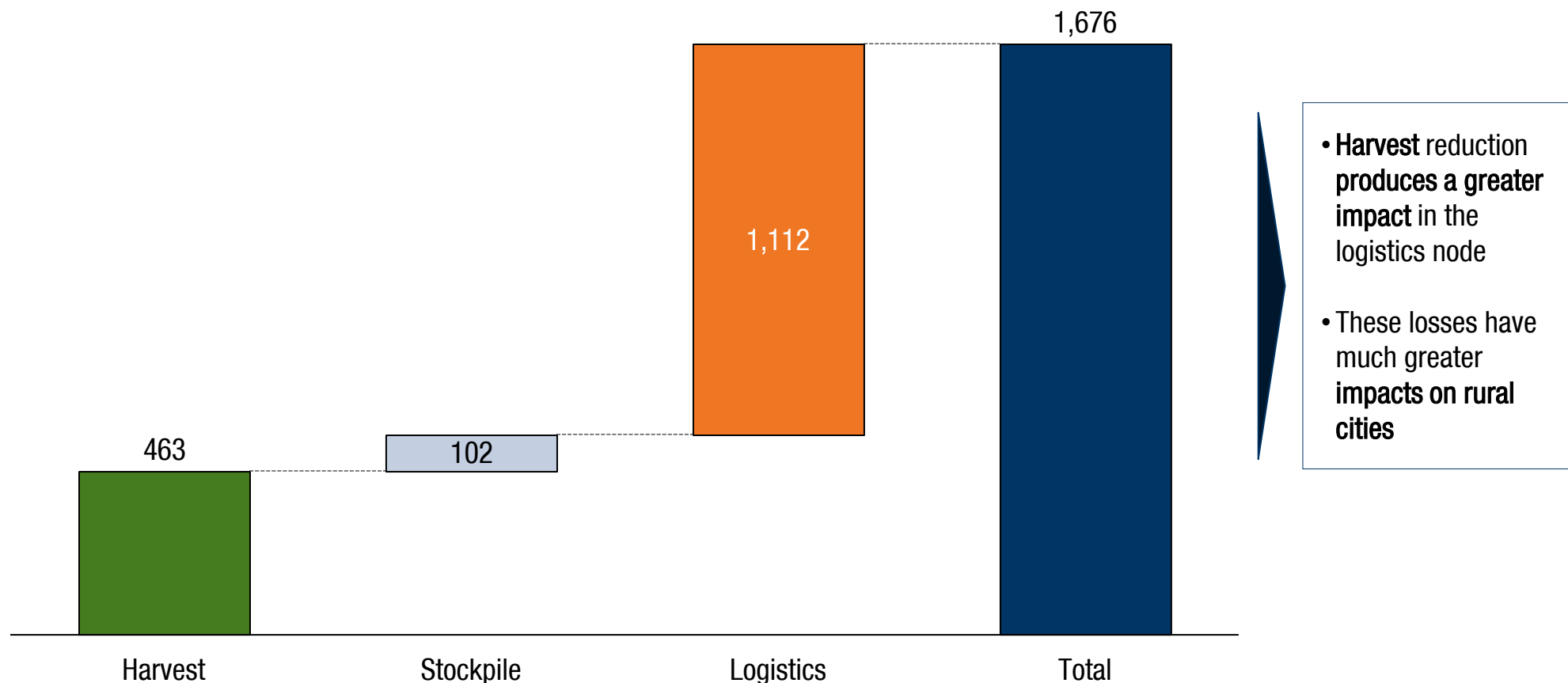
- Harvest reduction means **more than 586 thousand round trips by truck** which will never be made ...
- ... which represent a reduction of **2,000 million kilometers** to be ridden...
- ... with a great impact in the whole economy around logistics

Source: Sebastián Senesi et al, Head of Departamento de Instituciones, Organizaciones y Estrategia – FAUBA.

The agribusiness system loses revenues for an amount of USD 1,676 million caused by ban

Millions of USD.

Lost income for the neonicotinoids and phenylpyrzoles ban in the Argentine SAG (Agricultural and Livestock Service)



Source: Sebastián Senesi et al, Head of Departamento de Instituciones, Organizaciones y Estrategia – FAUBA.

Final remarks

Social and economic impact

- Economic losses of USD 6,5 billion and for the whole system are produced
 - 72% belongs to the **private sector**, especially over production, harvest and logistics
 - 28% belongs to the **Government**, with the consequent result over the services the Government renders
- There is also a **negative effect over workforce**, when almost **9 thousand jobs** were lost directly or indirectly in the whole system
- **2 thousand harvest pieces of equipment** (about 10% of the present fleet) and **6.5 thousand trucks would not be used**

Black market creation

- **Ban** could lead to this technology **smuggling** which, in terms of quality analysis, would mean the losses of:
 - **Traceability** and potential loss of **quality** of products in use
 - Governmental **audit** over new products containing **forbidden molecules**
 - **Federal revenues** due to lack of payment of sales taxes or customs duties

Impact over new production plan

- Work is done **based on the present mix of crops**, with 66% of the area sowed with soybean
- Since future campaigns consider **an increase of other crops** and a potential reduction of the area for soybean ...
- ... there is a **possibility of even more hectares becoming economically unfeasible** with the neonicotinoids and phenylpyrazoles ban since crops such as corn, wheat and sunflower highly demand the use of these technologies