How can we get away from the high use of pesticides in fruit growing?

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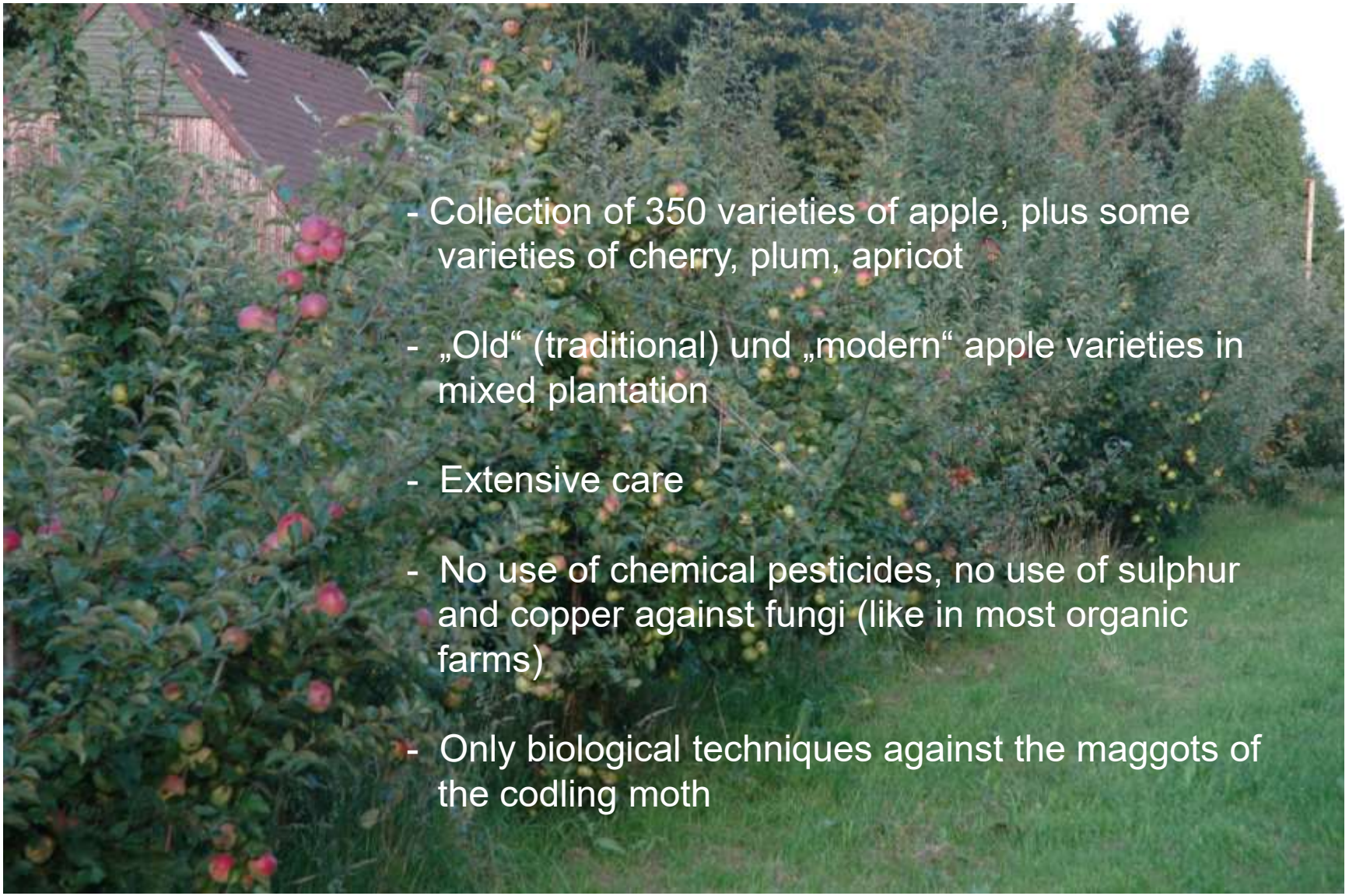
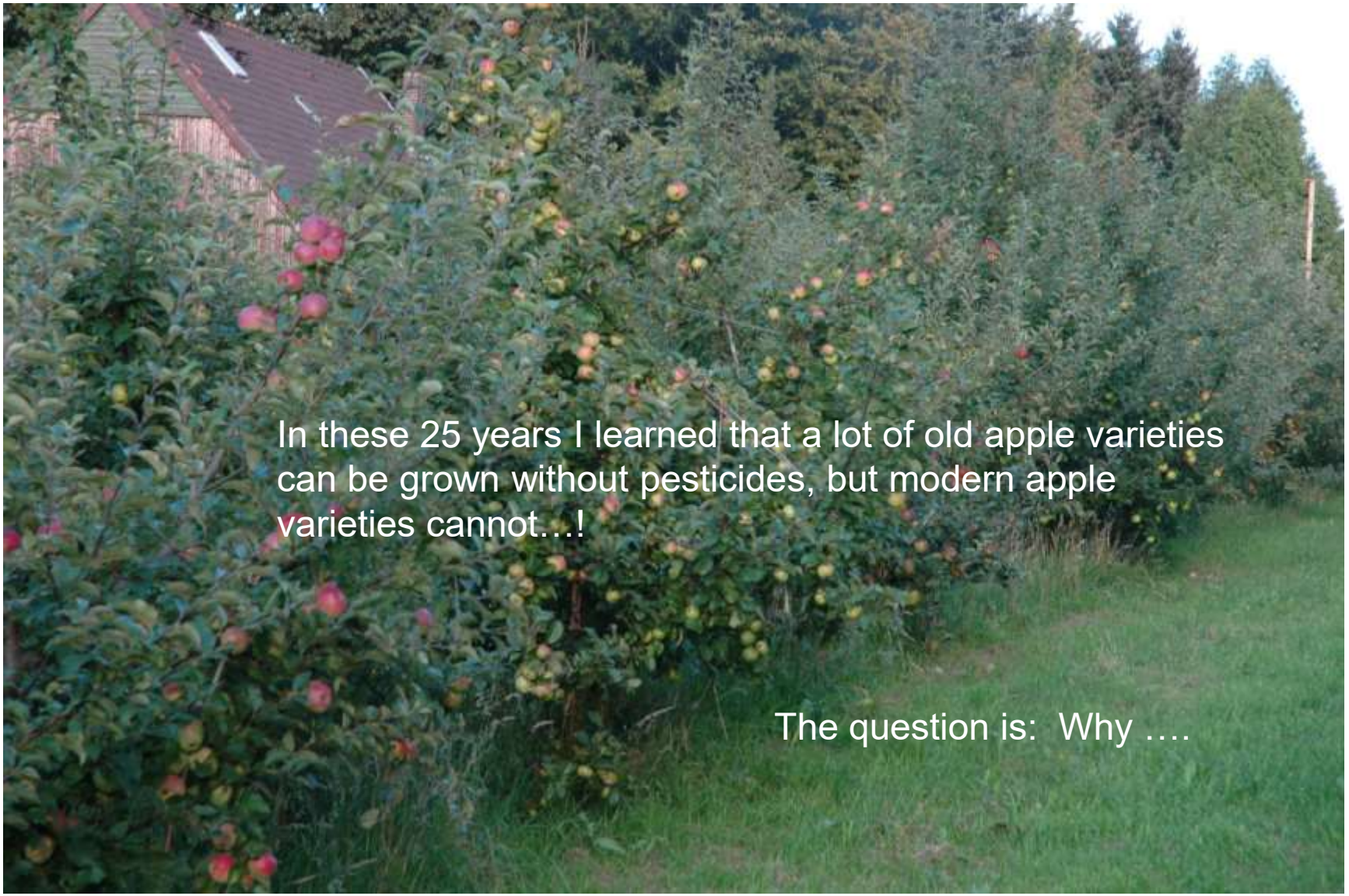
Apple orchard ‚Obstarboretum Olderdissen' (Bielefeld) since 1994



- Collection of 350 varieties of apple, plus some varieties of cherry, plum, apricot
- „Old" (traditional) und „modern" apple varieties in mixed plantation
- Extensive care
- No use of chemical pesticides, no use of sulphur and copper against fungi (like in most organic farms)
- Only biological techniques against the maggots of the codling moth

Apple orchard ‚Obstarboretum Olderdissen' (Bielefeld) since 1994



What is the problem in the apple orchards today ?

The beautiful world of apples in the supermarket deceives us…

We have a big problem in fruit growing today with the modern varieties…

... but you only can see it, if you grow our supermarket apples without spraying any pesticides!

Modern fruit growing today :

→ Fruit growing is one of the agricultural crops with the highest use of pesticides (PSM)

→ Contrary to all claims of "integrated cultivation" and more precise use of PSM: The amount of pesticides used per hectare of orchard in Germany is still rising from year to year.

→ Diseases and pests (and what we can do against them) are the dominant topics in the fruit growing journals (right and left flanked by the advertisements of the chemical companies and their pesticides...!).

→ 20 to 35 sprays with various pesticides (fungicides, herbicides, insecticides) from the fruit blossom in springtime to the harvest in autumn are quite common in fruit growing

→ As fruit consumers, we also eat residues of pesticides. We have limit values for individual PPPs, but not for the cumulative effect of cocktails of various PPPs.

→ **Fruit growers today agree:**
"Fruit growing without the use of pesticides - that's unthinkable!"

The main problem in modern apple orchards is the scab (Apfelschorf)

Organic fruit growers are not allowed to use any systemically acting chemical agents (because they are absorbed by the plant, work "from inside", but also cause residues in the fruits).

Instead of them they prophylactically spray sulphur/Schwefel (and copper/Kupfer) to fruits and leaves, to keep away any fungal infections.

Depending on the weather conditions and the amount of rain, 30-60 sprays can be necessary against apple scab (and other leaf diseases) between fruit blossom and harvest.

For us as fruit consumers that’s no problem, because copper and sulphur don't go into the fruit. But copper accumulates in the soil and can have a negative effect on soil life; the spraying of sulphur and copper also change the leaf flora and indirectly damages beneficial insects - with the result that further spraying against other pests (for example: aphids/Blattläuse) becomes necessary.

To grow apples without intensive (biological) plant protection, for organic fruit growers with today's apple varieties seems completely unthinkable.

Has the situation always been like this?

Since when have chemical pesticides been available?

What did the fruit growers do in former times,
when they had no chemical pesticides?

Let's look back a bit in the apple history…

-- the oldest apple variety in Germany

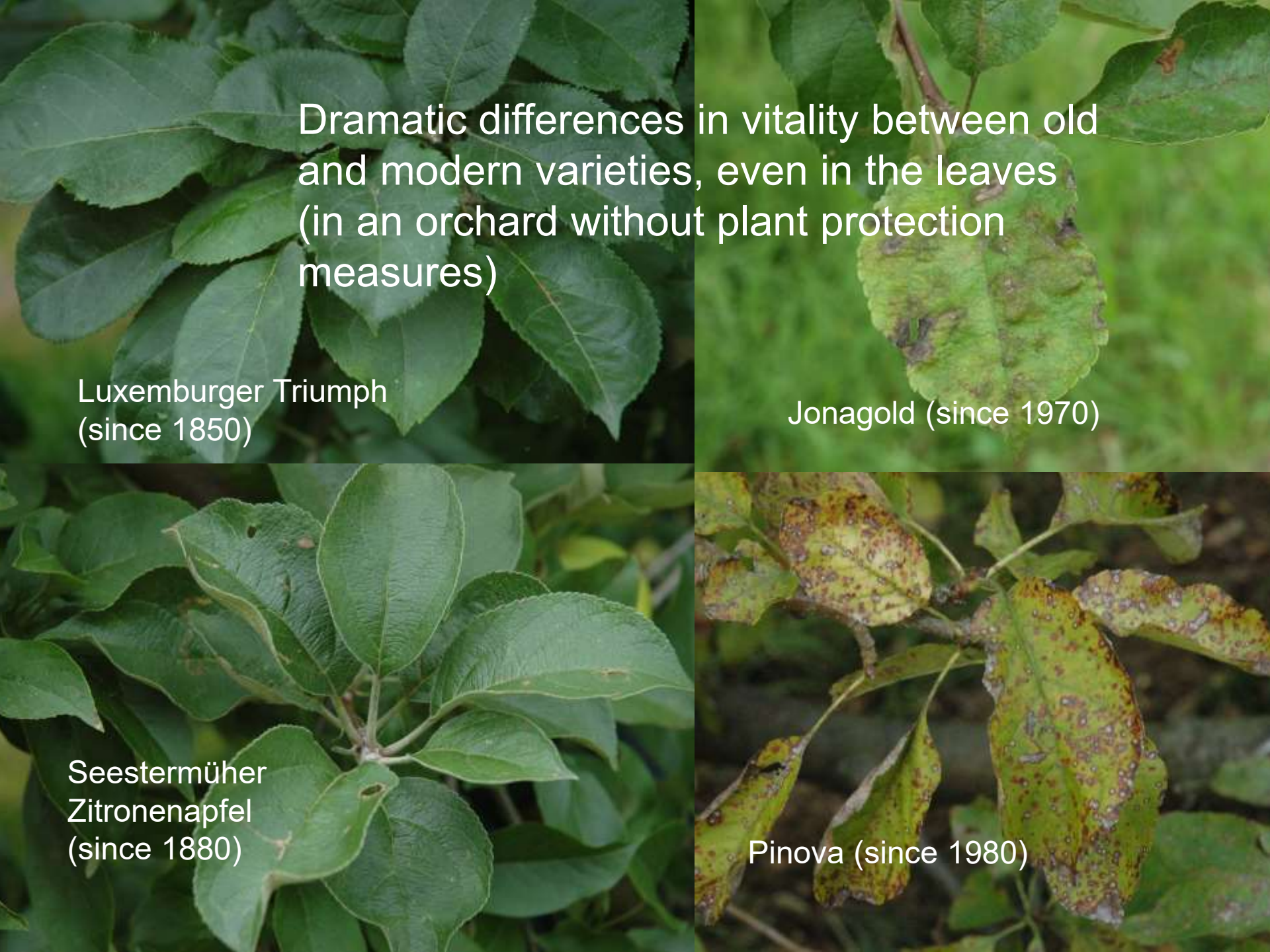
(originated in a monastery in the East of Germany, 13th century)

- 800 years long tolerant against scab
- tolerant against cancer (Obstbaumkrebs)
- tolerant against mildew (Mehltau)

Variety

‚Edelborsdorfer‘


Martens Sämling
(Martens seedling)
Luxemburger Triumph
(Triumph of Luxemburg)
All these old varieties are very tolerant against scab, mildew and cancer !
Seestermüher Zitronenapfel
(Lemon apple of Seestermühe,
North Germany)
Finkenwerder Prinzenapfel
(prince apple of Finkenwerder)


Dramatic differences in vitality between old and modern varieties, even in the leaves (in an orchard without plant protection measures)
Luxemburger Triumph (since 1850)
Jonagold (since 1970)
Seestermüher Zitronenapfel (since 1880)
Pinova (since 1980)

What has happened ??

Fruit growing before 1900

Fruit growing before 1900 was almost exclusively a sideline on farms in Germany (on high stam trees).

Chemical pesticides didn't exist.

Only robust varieties could be grown on a large scale.

Only a part of the varieties were table apples for direct eating. Many varieties were good for the kitchen for cooking or drying, for juice or fruit brandy a.s.o.

Varieties, which are susceptible against diseases (like 'Cox Orange'), were seen as 'Liebhabersorten‘ (“varieties you must love”), because only for best places and with high maintenance, but not for growing on large scale.

New varieties before 1750/1800 mostly were found as so-called random seedlings, not as a result of targeted breeding. Only robust varieties were able to establish themselves.

Apple breeding 1850 - 1930

- Start of targeted cross-breeding, in which pollination is no longer left to the bees.

- The aim was to find out more aromatic table apples for mass production (for marketing in growing cities).

- The breeders often crossed one of the highly aromatic, but disease-prone “lover varieties” (like 'Cox Orange') with a robust and high yield variety.

- The aim was to find (with a little luck) varieties, which are robust mass carriers and at the same time aromatic dessert apples

- Only varieties that could be cultivated without spraying (or with only minor plant protection measures), could be established


To example: ‚Holsteiner Cox‘
(‚Cox Orange‘ x ‚Ananas-Renette‘, 1903)
- Highly tolerant against apple scab


To example: ‚Alkmene‘ (about 1930)
(‚Geheimrat Oldenburg‘ x ‚Cox Orange‘)
- Highly tolerant against scab, mildew and cancer (Schorf, Mehltau, Obstbaumkrebs)

The turn to modern fruit growing

In America since the 1930s, in Germany since the 1950s:

Mass cultivation of the apple varieties '**Golden Delicious**', '**Jonathan**', '**McIntosh**' (all originated from America) and '**Cox Orange**' (old English variety)

What are these new apple varieties?


Golden Delicious
The „scab-champion“


Jonathan
The „mildew-champion“


The „cancer-champion“
Cox Orange

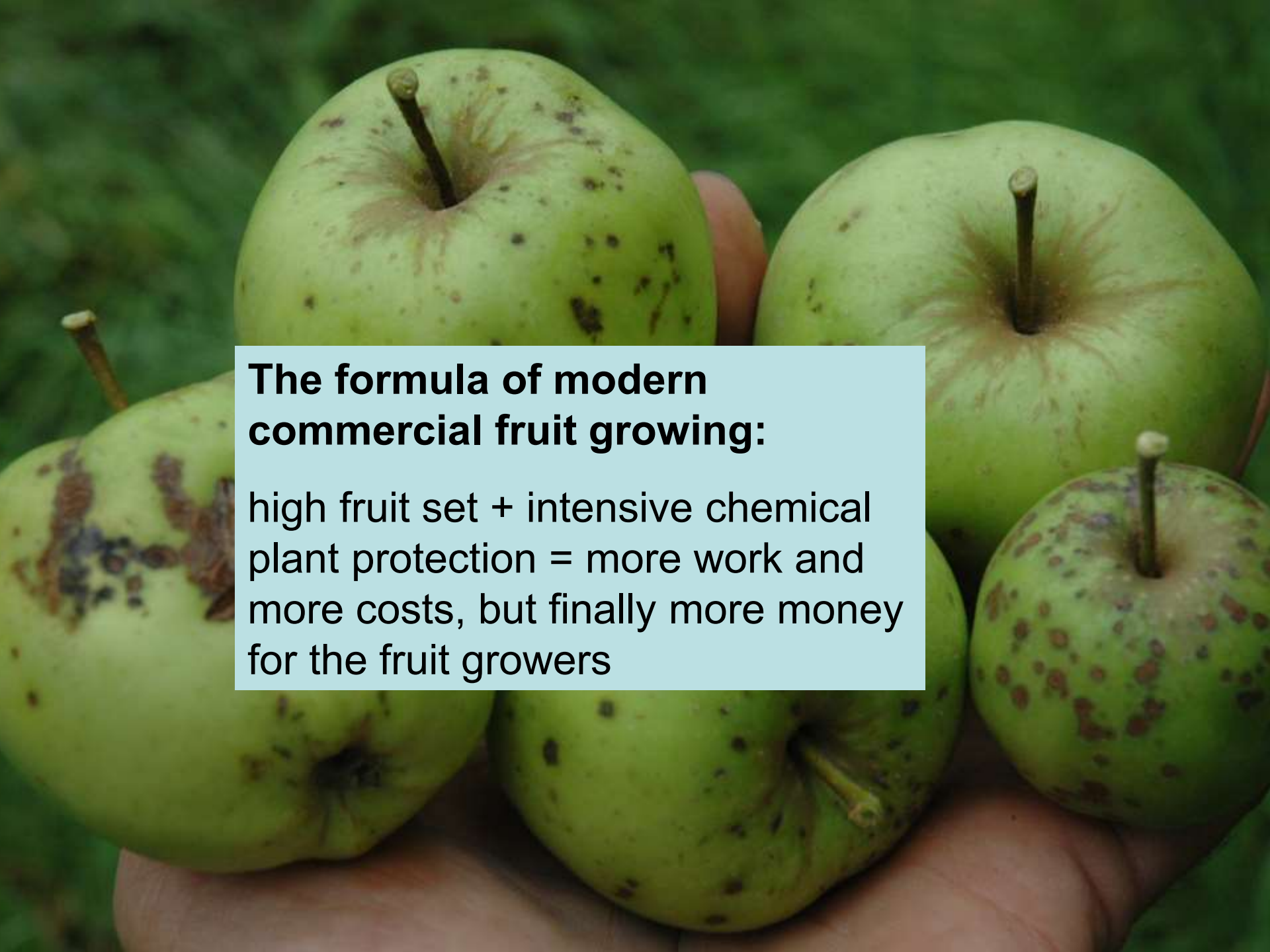

Mc Intosh
Highly sensitive for scab and mildew

Until 1930 these varieties had no significance - what was suddenly so attractive about them?

The reasons for the triumph of the Golden Delicious:

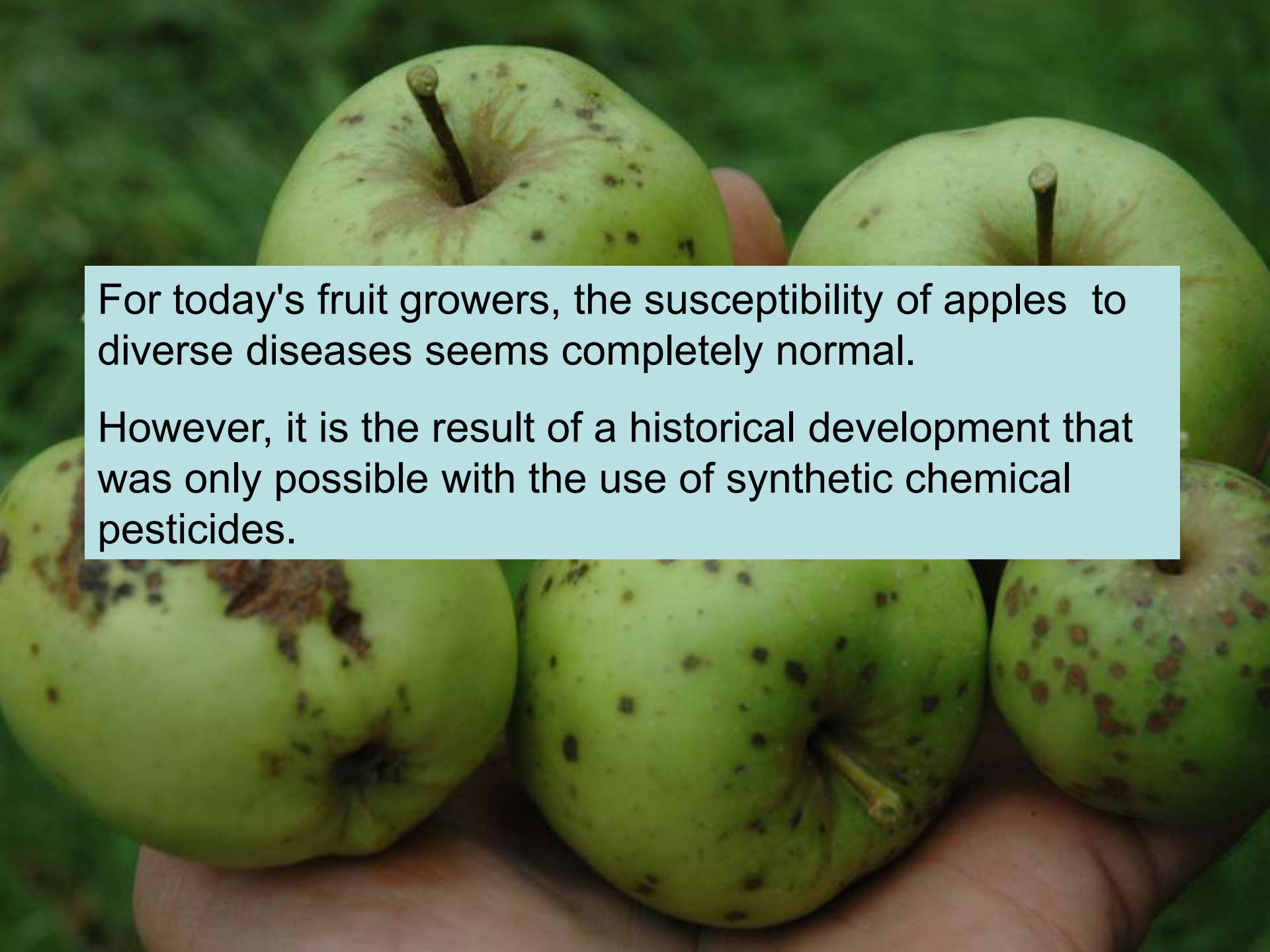
- extremely high and regular flower set, so a potentially high fruit yield (but only if you spray against scab!)
- the fruit is hard and well transportable
- the fruit has a mild sweet aromatic taste
- the fruit has a long stem (for easyer harvest)

But all this was only possible with the use of the new chemical synthetic pesticides !



The formula of modern commercial fruit growing:

high fruit set + intensive chemical plant protection = more work and more costs, but finally more money for the fruit growers



For today's fruit growers, the susceptibility of apples to diverse diseases seems completely normal.

However, it is the result of a historical development that was only possible with the use of synthetic chemical pesticides.

Fundamental turn also in the apple-breeding (since about 1930):

→ All breeders worldwide suddenly only bred with the following 5 highly susceptible parent varieties:

The "grandfathers" of modern apple breeding since 1930:

Golden Delicious
Cox Orange
Jonathan

+ in America also the varieties

McIntosh
Red Delicious

Compilation: Hans-Joachim Bannier

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+ in America also the varieties

McIntosh
Red Delicious

Compilation: Hans-Joachim Bannier

- → **The breeding target "vitality" is no longer the primary focus of breeders !!**
- → **This development results in an extreme genetic impoverishment (narrowing), that has never existed before.**

Today's market varieties and new varieties of apples and their parents and grandparents

- Jonagold (USA) = ***Jonathan*** x ***Golden Delicious***
- Elstar (NL) = ***Golden Delicious*** x Ingrid Marie (***Cox orange*** x unbek.)
- Gala (NZ) = Kidds Orange (***Red Delicious*** x ***Cox Orange***) x ***Golden Delicious***
- Idared (CAN) = ***Jonathan*** x Wagenerapfel
- Pinova (D) = Clivia (Oldenburg x ***Cox orange***) x ***Golden Delicious***
- Akane (Syn. Primerouge) (J) = ***Jonathan*** x Worcester Parmäne
- Delbarestivale (Syn. Delcorf) (F) = Stark Jon Grimes x ***Golden Delicious***
- Pink Lady (Syn. Cripps Pink) (NZ) = Lady Williams x ***Golden Delicious***
- Fuji (J) = Ralls Janet x ***Golden Delicious***
- Nicoter (Syn. Kanzi) (B) = Gala (***Red Delicious***, ***Cox orange***, ***Golden Delicious***) x Braeburn
- Rubinette (Syn. Rafzubin) (CH) = ***Golden Delicious*** x ***Cox orange***
- Melrose (USA) = ***Jonathan*** x ***Red Delicious***
- Summerred (USA) = Summerland (***McIntosh*** x ***Golden Delicious***) x unbekannt

Compilation: Hans-Joachim Bannier

The result: We observe a

- obviously higher susceptibility of modern (compared to traditional) varieties to scab.

- obviously higher susceptibility of "modern" (compared to traditional) varieties to mildew

- obviously higher susceptibility to Elsinoe leaf spots ('Topaz spots') of "modern" (compared to traditional) varieties

- higher susceptibility to viruses (apple proliferation) with far-reaching consequences for plant hygiene

Great challenge for organic fruit growers…

… the call to the breeders to give us more resistant varieties becomes louder !

How have the breeders tried to solve the problems in the last 40 years?

- They have **not** used robust traditional varieties for their breeding.

- Instead, the Japanese wild apple 'Malus floribunda' was crossed into the susceptible modern varieties.

Why ?

Why a little wild apple in the modern apple breeding?

- The scab resistance of Malus floribunda can be located on a single gene (monogenic scab resistance)
- Whether the crossbreeding of the 'scab resistance gene' was successful or not, can be checked immediately with today's molekular biological methods.
- So crossbreeding of scab resistance is more "predictable" than using (polygenic) old varieties.

Monogenic scab resistance = acceleration and better manipulability of the breeding !

Pedigree of the varieties ‚Topaz‘ and ‚Merkur‘ (Czech breeding)

Gold. Delic. x Vf

McIntosh x Newtown Pepping 14 – 26 x **Jonathan**

J. Grieve x Worc. Parmäne Spartan x 38 OR T16 **J.Grieve** x Worc.Parmäne

Lord Lambourne x **Gold. Delic.** Jolana x Lord Lambourne

Rubin x Vanda

Topaz

Merkur (Zuchtklon UEB 3531-3)

Rajka

Shampion x Katka

Gold. Delic. x **Cox Orange** Jolana x Rubin

Spartan x 38 OR T16 L.Lambourne x **Gold. Delic.**

McIntosh x Newtown Pepping 14 – 26 x **Jonathan** **J. Grieve** x Worc. Parmäne

Golden Delic. x vf

The problem:

- „Nearly 95% of the today‘ scab resistent apple varieties are build on the Vf-resistance of Malus floribunda 821“

F.X. Ruess, „Resistente und robuste Kernobstsorten“, Hrsg. Staatl. Lehr- und Versuchsanstalt für Wein- und Obstbau Weinsberg (2000)

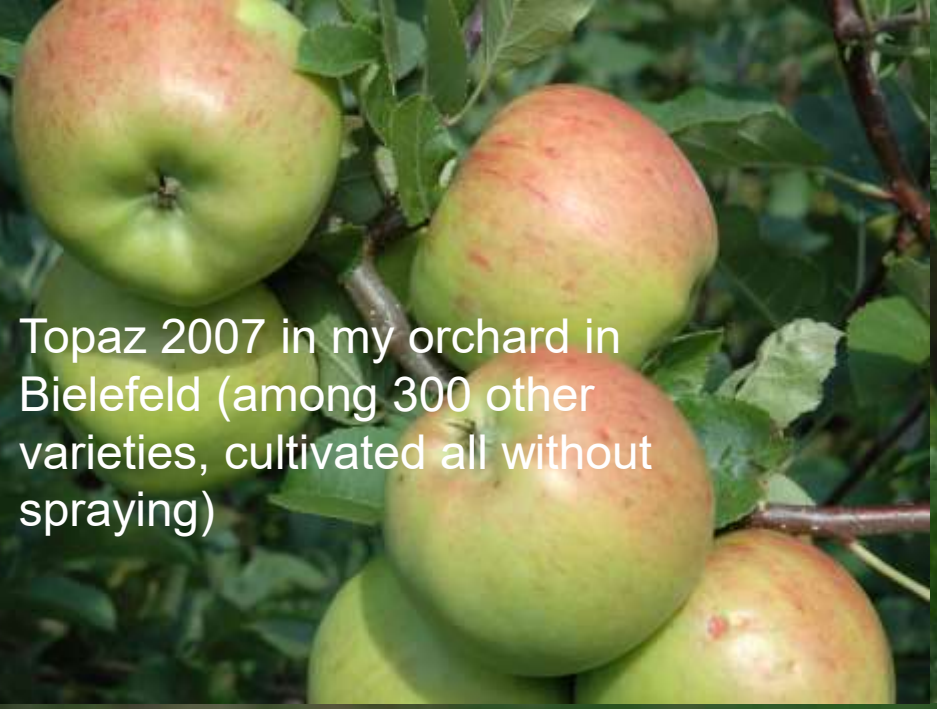
- So the many scab-resistent breeds of the last 50 years are also all offspring of the very disease susceptible „grandfathers“ **Golden Delicious, Jonathan, McIntosh** und **Cox Orange** !

- The worldwide using of ‚Malus floribunda‘ in apple breeding **promotes further genetic impoverishment**

The result:

- Outside in the field the scab resistance of the modern breeding varieties broke down on a broad front.

Breakdown of scab resistance in the varieties …



Topaz 2007 in my orchard in Bielefeld (among 300 other varieties, cultivated all without spraying)

First breakdowns of scab resistance in an orchard in Neubeckum (Westfalen), where only modern scab-resistant varieties were planted, cultivated without spraying.

‚Topaz‘ 2007

Topaz 18.07.2019

My orchard in Bielefeld, without spraying:

Total breakdown of scab resistance – scab on fruits and leafs

Conclusion:

The strategy of monogenetic scab resistance in apples has failed completely.

Against a single resistance gene, which is completely "left alone" by the rest of the neighbouring genes of an incestuously overbred apple variety, scab has an easy game to crack the resistance by making small mutations on its part.

We don’t speak about "a little bit of scab", but about a complete breakdown of resistance !

The result:
Fruit growers must continue to use their fungicides...

The counterargument:

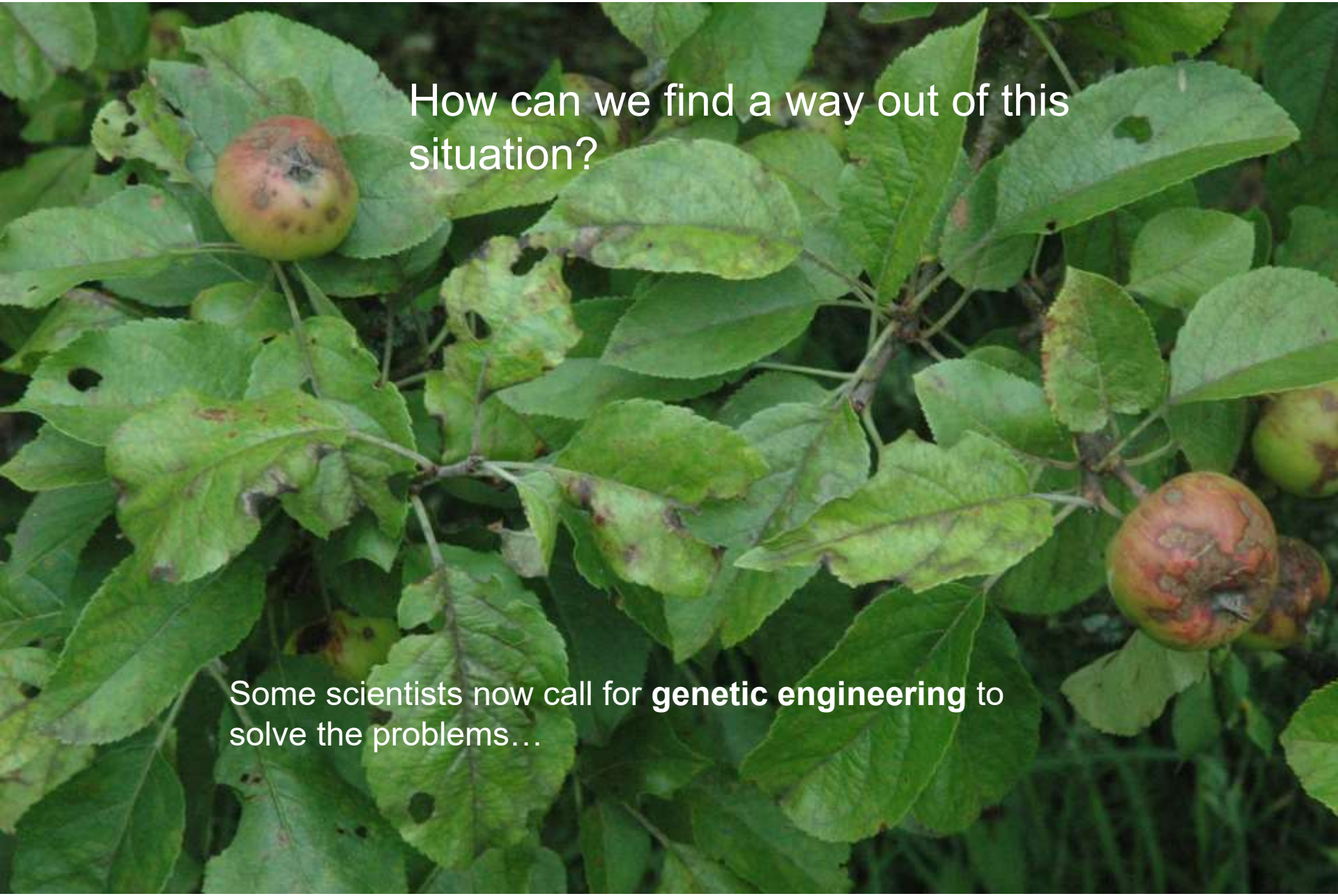
"Not the genetic constitution of a variety is the reason, why resistance will collapse, but mass production is the reason. If we would grow the robust old varieties in the mass cultivation of the commercial fruit production, their resistances would also be collapsed soon.

This argument also does not stand up to a fact check:

Many of the old varieties were once just as strong in mass cultivation as the Topaz today (e.g. Holsteiner Cox, Alkmene, Boskoop, Gravensteiner).

None of these varieties have lost their own characteristics in terms of health via the Decades as much as the 'Topaz' lost his resistance.

In addition: many of the modern varieties, whose monogenic scab resistance are now collapsing, have never been in mass production at all - yet her resistance collapses! (e.g. 'Prima', 'Aneta', 'Lotos', Rewena, etc.).



How can we find a way out of this situation?

Some scientists now call for **genetic engineering** to solve the problems…

e.g. Prof. Niggli:

gut gezielt verändert wer-
Gentechnik gekennzeichnet
wissen. Urs Niggli, Direktor des Forschungsinstituts für biologischen Landbau in Frick, sieht auch die Chancen der Technologie.

Professor Niggli, was halten Sie von „Genome Editing"?
Für die Pflanzenzüchtung ist Genome Editing, vor allem die neueste Methode, Crispr Cas 9, ein Top-Verfahren.

FOTO: FIBL

of. Dr. Urs Niggli, Direk-
r des Forschungsinstituts

Aus: Lebensmittel-Zeitung 06/2018

ße Chancen birgt.

Können Sie ein Beispiel nennen?
Nehmen Sie die Schorfresistenz bei Äpfeln. Man kann diese Eigenschaft durch Einkreuzen des japanischen Holzapfels erzielen, der ein Resistenzgen gegen den Schorf enthält. Die Rückkreuzungen, die sicherstellen, dass keine weiteren unerwünschten Eigenschaften im Kulturapfel landen, dauern zehn bis zwanzig Jahre. Mit Crispr kann man das betreffende Gen aus dem Holzapfel gezielt und schnell in den Kulturapfel einfügen – und das Ergebnis ist viel besser.

Ein Streitpunkt ist die Regulierung. Was ist Ihre Meinung?
Technisch finde ich die Empfehlung eines der Generalanwälte des Europäischen Gerichtshofs sinnvoll. Demnach sollte Crispr, sofern man nicht mit artfremden Genen arbeitet, nicht unter das Gentechnik-Gesetz fallen.

eine sachliche Analyse von Chancen und Risiken ist wichtig, um auf lange Sicht – auch außerhalb der Nische ökologischer Landbau – die Weichen für eine na
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Wie groß ist das Potenzial?
Weltweit arbeiten derzeit Hunderte von staatlichen Instituten mit Crispr Cas 9. Da kommt eine Welle an Innovationen auf uns zu, die nicht nur einen kommerziellen, sondern auch

"Take the scab resistance of apples. This property can be achieved by crossing in the Japanese wooden apple, which contains a resistance gene against scab...

With Crispr you can insert the relevant gene from the wood apple into the cultivated apple quickly and specifically - and the result is much better."

???

The same strategy of monogenetic scab resistance, which has just failed, should suddenly be successful with genetic engineering?

It is foreseeable that Prof. Niggli is promising us here “a castle in the air”...

In meantime, apologists for genetic engineering have changed their argumentation. They claim that the collapse of resistance in cultivated plants is quite normal as a law of nature.

They claim, that we need genetic engineering because we can react faster on such breakdowns than with conventional crossbreeding.

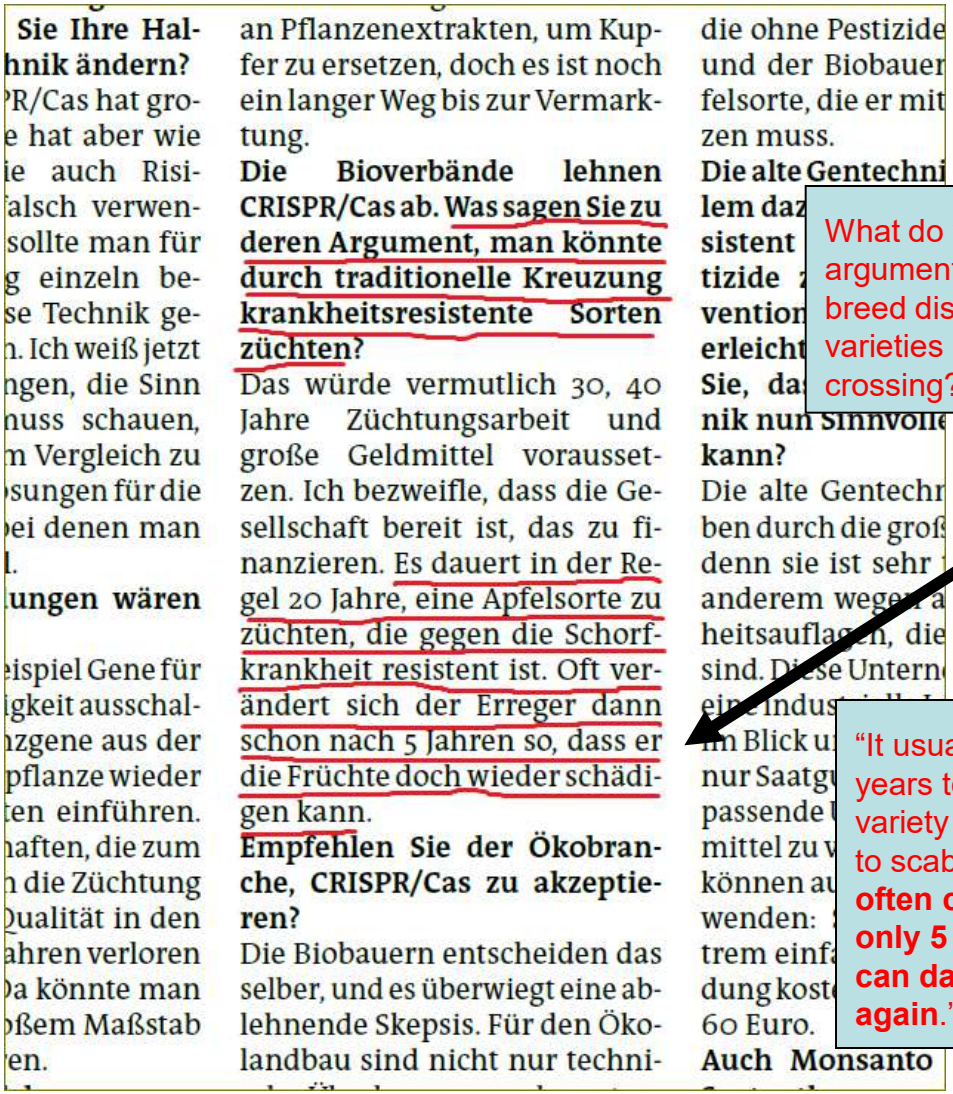
Mit CRISPR/Cas könnten "*die Resistenzeigenschaften einer Kultursorte schnell und mit vergleichsweise wenig Aufwand* (also schneller als mittels klassischer Kreuzungszüchtung) *den sich immer wieder ändernden Strategien der Krankheitserreger angepasst werden*."

Die Züchter müssten deshalb mit ihren Sorten (wie im ewigen Wettlauf zwischen Hase und Igel) "*den wandlungsfähigen Schädlingen und Krankheitserregern immer einen Schritt voraus sein*".

Resistenzeigenschaften von Pflanzen seien nun einmal „*im Verlauf der jahrhundertelangen Züchtung verloren gegangen*".

(so the ‚Forum Bio- und Gentechnologie e.V', see www.transgen.de)

Prof. Niggli again:



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an Pflanzenextrakten, um Kupfer zu ersetzen, doch es ist noch ein langer Weg bis zur Vermarktung.

Die Bioverbände lehnen CRISPR/Cas ab. Was sagen Sie zu deren Argument, man könnte durch traditionelle Kreuzung krankheitsresistente Sorten züchten?

Das würde vermutlich 30, 40 Jahre Züchtungsarbeit und große Geldmittel voraussetzen. Ich bezweifle, dass die Gesellschaft bereit ist, das zu finanzieren. Es dauert in der Regel 20 Jahre, eine Apfelsorte zu züchten, die gegen die Schorfkrankheit resistent ist. Oft verändert sich der Erreger dann schon nach 5 Jahren so, dass er die Früchte doch wieder schädigen kann.

Empfehlen Sie der Ökobranche, CRISPR/Cas zu akzeptieren?

Die Biobauern entscheiden das selber, und es überwiegt eine ablehnende Skepsis. Für den Ökolandbau sind nicht nur techni-

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Auch Monsanto

What do you think about the argument that you can breed disease-resistant varieties by traditional crossing?

"It usually takes 20 years to breed an apple variety that is resistant to scab. **The pathogen often changes after only 5 years so that it can damage the fruit again**."

Taz v. 6.4.2016

But also this argumentation is totally failing…

Such a complete breakdown of resistance has never happened before in the history of apple cultivation –

- neither in the old varieties

- nor in the breeding varieties of the century between 1830 - 1930

- There were susceptible varieties and resistant varieties, but no varieties, which were resistant at first and after a few years suddenly high susceptible.

- **The sudden collapse of resistances has only been known to us, since breeders believe that it is possible to make our highly disease susceptible apples healthy by inserting individual genes.**

What should a sustainable and ecological apple breeding look like?

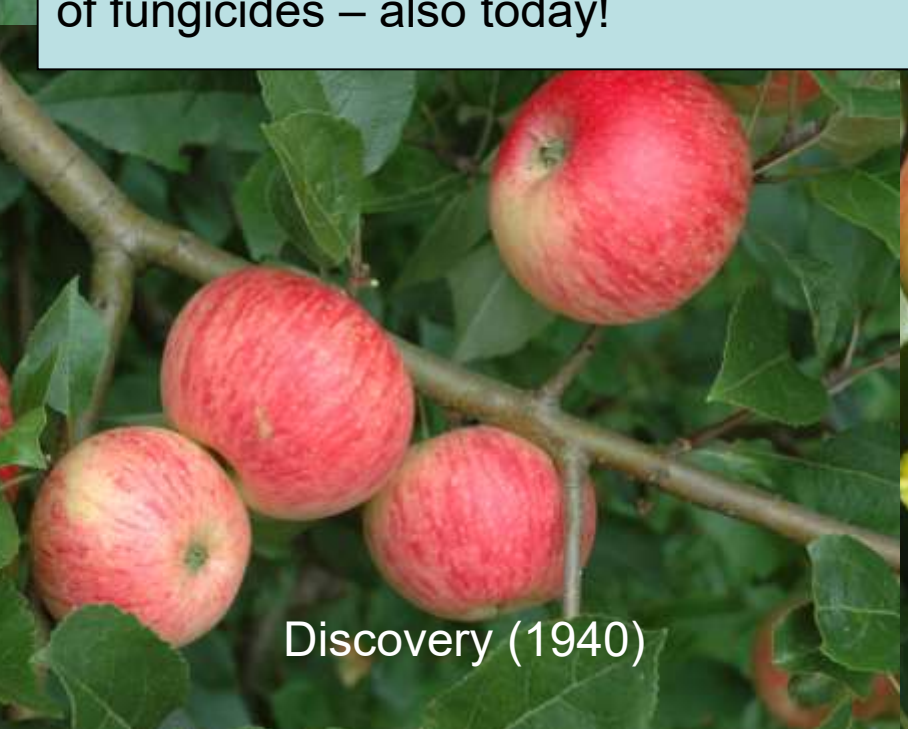
Shall we

- continue to save our highly disease-prone and genetically narrowed varieties for a few years by inserting individual genes?

- or make a "system change" and use again vital and polygenetic resistant traditional varieties for our breeding, even if we need more time for the crossbreeding?


Vital, robust varieties, interesting for breeding dont exist only in Kazakh or Kyrgyz wild apple forests, but also in old apple orchards in Europe

The crossbreeds from 1850 to 1930 show us that this way has produced sustainable results. These apple varieties can be grown without intensive use of fungicides – also today!



To example:

Seestermüher Zitronenapfel

- High resistent against Scab, cancer and mildew
- Early, high and regular yield
- Medium-strong growth, with onset yielding weak growth
- Always uniform fruit size, no thinning required !

This way may take longer, but I am convinced that it leads to more sustainable results !

Progress in breeding in this direction has been interrupted for 80 years...

Unfortunately, the government today gives much money for genetic engineering, but no money for ecological sustainable breeding...

With the private breeding association Apfel:gut e.V. since a few years we continue in principle where the breeders stopped in 1930... !

What has been shown here may also apply in a similar form to other agricultural crops.

The fact that we can show it so precisely at the example of apple varieties has to do with the fact that apple trees (as they were planted in the past) have the property of possibly becoming 100 years old and older, i.e. we still know the old varieties from earlier centuries, can reproduce them and observe them.

Many other cultivated plants are lost as soon as they are no longer actively cultivated.

Thank you for your attention !

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Epilogue about genetic engineering for apple cultivation:

If companies or scientists want to "push" genetic engineering in the political arena (because genetic engineering in food in Europe is predominantly rejected by consumers), they prefer to argue that genetic engineering can secure the world's food supply, that genetic engineering can help reduce the consumption of pesticides or can produce food with better health properties and so on.

And what happens if genetic engineering - as in the USA - is actually allowed?
The so-called 'arctic apples' have been in cultivation in the USA since 2017. Genetic engineering prevents the fruits from turning brown so that they look fresh for longer after pruning. In this way, consumers are deceived about the actual freshness of the apple - in extreme cases also about possible contamination.

Health? Reducing of spraying agents? World nutrition? All the promised noble goals are forgotten!