

INTERNATIONAL  
**COTTON**  
CONFERENCE  
**BREMEN**

2024



20 – 22 MARCH 2024 | BREMEN PARLIAMENT HOUSE

## PRESENTATION

Session:  
**Recycling**

Title:  
Mechanically Recycled Cotton Ring Yarns

Speaker:  
**Michael Will, Maschinenfabrik Rieter AG, Winterthur (Switzerland)**

### **Conference Organisation**

Faserinstitut Bremen e.V., Bremen, Germany. E-Mail: [conference@faserinstitut.de](mailto:conference@faserinstitut.de)

Bremer Baumwollbörse, Bremen, Germany. E-Mail: [info@baumwollboerse.de](mailto:info@baumwollboerse.de)



# **Mechanically Recycled Cotton Ring Yarns**

Three tools to improve yarn quality significantly

Michael Will / Head Textile Technology & Process Analytics

## Current Situation

- Most recycled fibers available today are mechanically recycled cotton fibers from post-industrial waste
- Chemically recycled fiber production not yet scaled up (expected 5-10 years to industrial scale): spinnability given by standard fiber staple length
- Rotor process is established, ring spinning is limited in mechanical recycled fiber share and applications

Industry expects solutions with little compromise on quality (and cost)

- Establish ring spinning process, increased recycled fiber content
- Processing of post-consumer waste (first pilot sorting lines in operation)



# A Challenging Raw Material

- Mechanically recycled fibers differ from virgin fibers in the following aspects:
  - Opening degree (remaining yarn and fabric pieces)
  - High short-fiber content
  - High nep count
  - High variation from lot to lot
- Due to the more challenging character of recycled fibers, spinners have to increase the effort to achieve the desired yarn quality on a constant level
- **Outlook:** Innovations and process improvements will lead to an improved raw material quality and processability in the future
- **Future needs:** Reliable sorting, improved opening and cleaning



Post-consumer Denim 2020



Post-consumer Denim 2023

# Rieter's Recycling Fiber Classification – Update 11/23



FIBER KEY PARAMETRES	SHORT-FIBER CONTENT (N)	MEAN FIBER LENGTH (N)	LONG FIBER 5%	NEPS (1/G)
Cotton short staple (< 1 1/8" as reference)	24%	21 mm	34 mm	150
Very good	< 45%	> 17 mm	> 31 mm	< 300
Good	< 55%	> 15 mm	> 27 mm	< 600
Medium	< 70%	> 12 mm	> 23 mm	< 900
Poor	> 70%	< 12 mm	< 23 mm	> 900

<https://www.rieter.com/products/system-applications/recycling-spinning-system>

# Rieter's Targets for Recycled Cotton Ring Yarns

## Benchmark is 100% virgin CO, carded

- Achieve same yarn count range
- Achieve comparable yarn quality range (unevenness, IPIs, hairiness, imperfections, abrasion)
- Achieve comparable production efficiency levels in spinning and downstream (yarn breaks, abrasion etc.)
- Achieve comparable fabric quality / lifetime

All of this should be achieved with the highest possible mechanically recycled cotton ratio (target for Ne 30 = 50%)

## Rieter's Toolbox to achieve Benchmark

- 1) Pre-Carding
- 2) Combing
- 3) Compacting



# Trial Set-Up

Reference ring yarn spun using the regular carded process



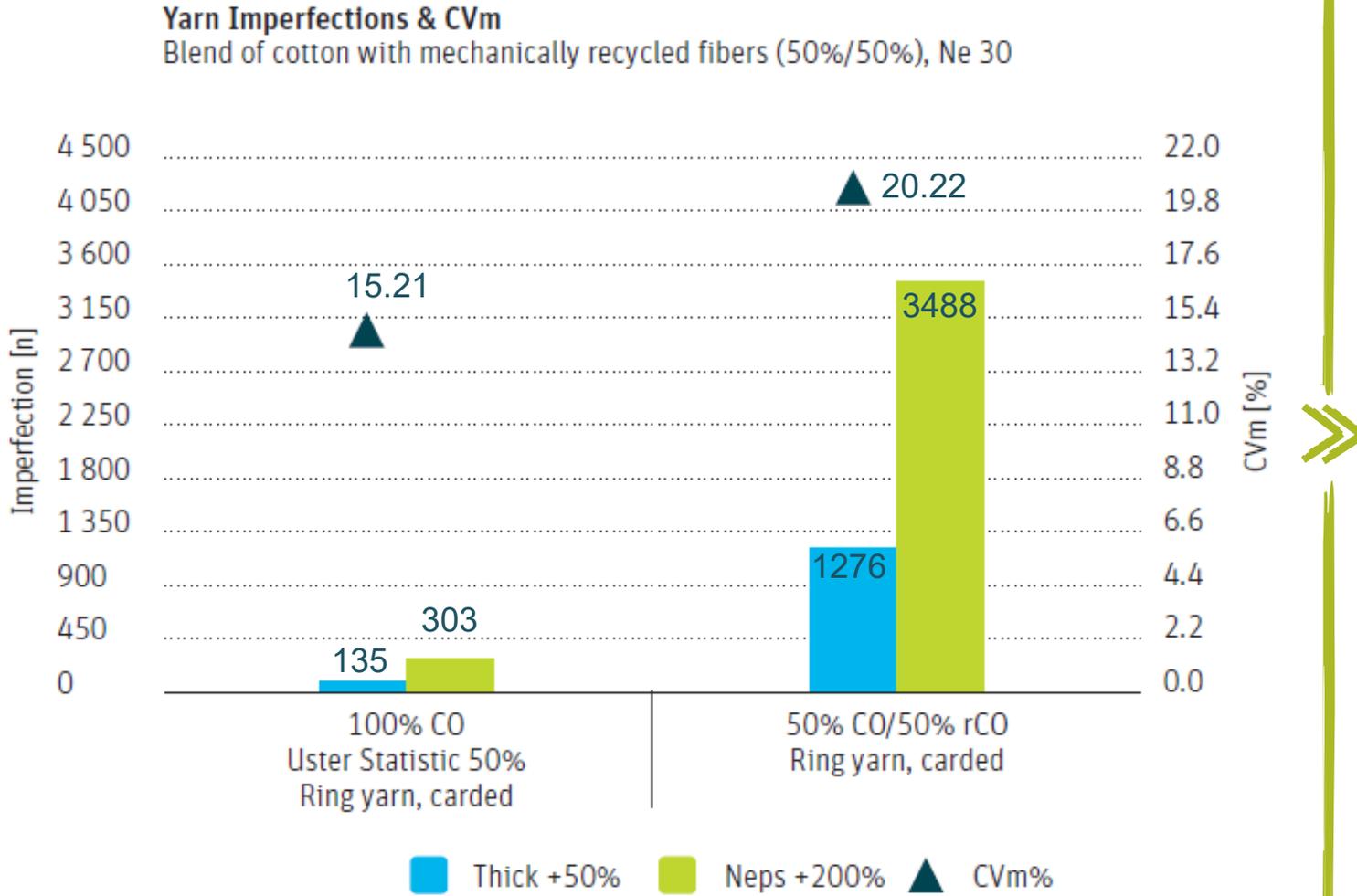
Raw material  
50% rCO /  
50% CO

Raw material		Cotton	Recycling
Origin		Senegal	Recover
<b>Test instrument</b>		<b>AFIS Pro 2</b>	
Commercial staple; UQL(w)	mm	29.8	17.1
5% - fiber length (n)	mm	34.1	20.7
Mean fiber length L (n)	mm	20.2	8.8
Short fiber content < 12.7 mm (n)	%	22.1	77.9
Fiber Neps	1/g	184.0	1007.0



# Impact of Mechanically Recycled Fibers on Ring Yarn Quality

## Regular Carded Process



### Results

- Adding recycled fibers increases the number of imperfections and the yarn unevenness significantly, while decreasing yarn tenacity.
- Spinning efficiency (yarn breaks) drops while machine soiling increases
- Lower production efficiency in downstream processes (higher yarn breaks, high abrasion)
- Fabric appearance is very neppy and uneven

**This yarn is basically not useable in the regular textile production process!**

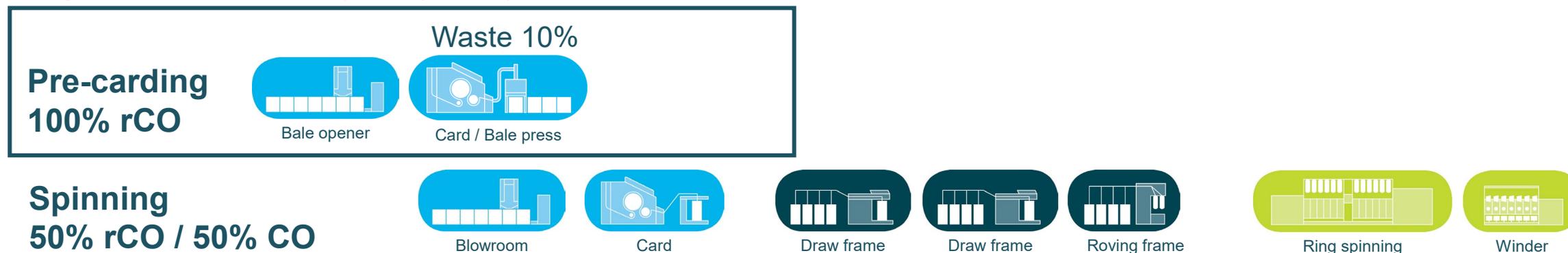
# Improving Yarn Quality Tool 1: Pre-Carding

Rieter's toolbox for spinning recycled cotton ring yarns

## 1. Pre-carding / fine-cleaning

**Description:** Cleaning step of the recycled fibers on a cotton card **before** entering the spinning process

**Target:** Removal of all yarn (fabric) pieces / reduction of fiber neps



Original recycled fibers



Recycled fibers after pre-carding

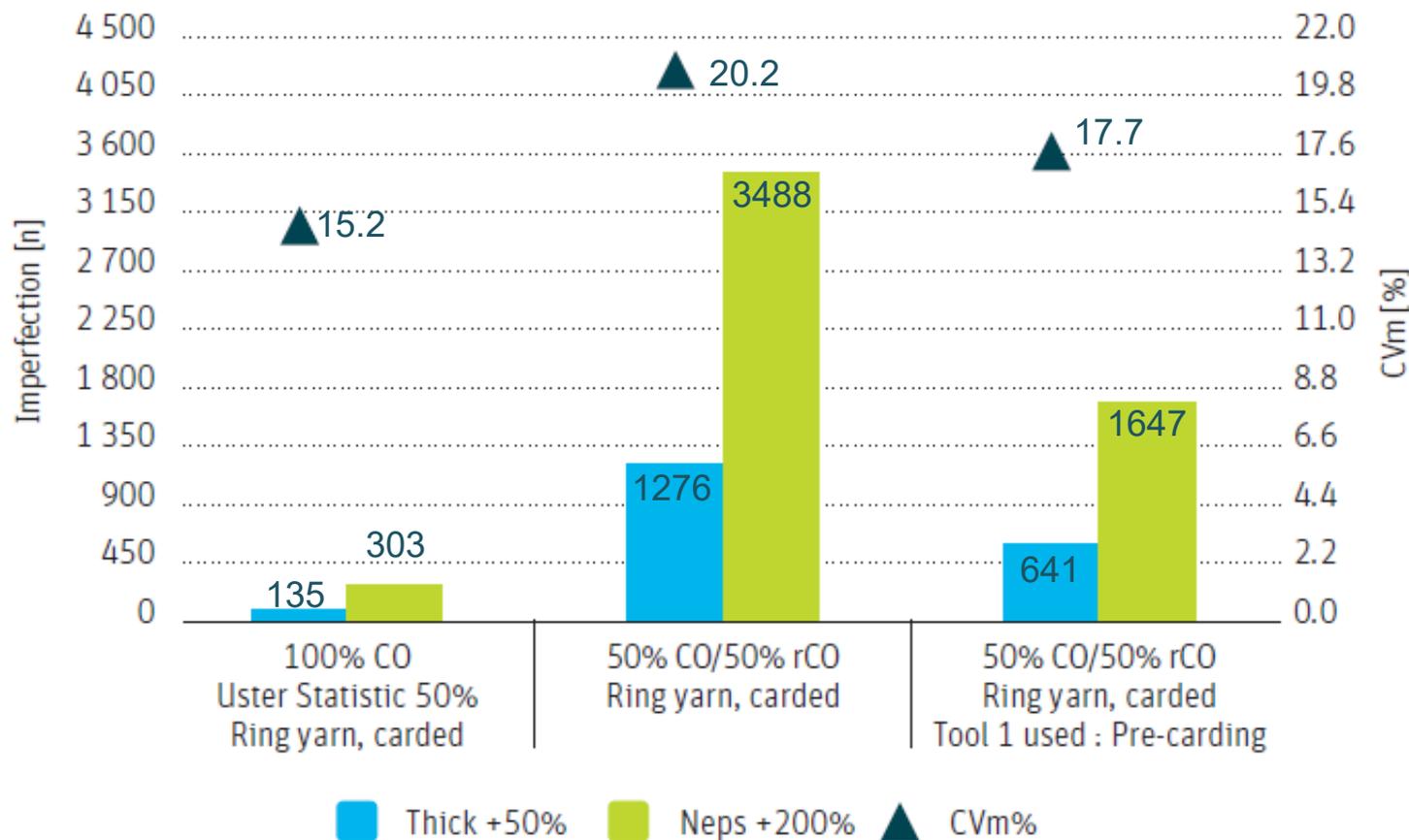


# Results of Tool 1: Pre-Carding

## Pre-carding of recycled material

### Yarn Imperfections & CVm

Blend of cotton with mechanically recycled fibers (50%/50%), Ne 30



### Process

- Pure recycled fibers are cleaned via a carding step and then baled
  - Removal of yarn pieces
  - Nep reduction
- Waste can be used for other applications (e.g. non-wovens)

### Results

- Pre-carding consistently delivers a reduction of thick places and neps **by around 50%**
- Yarn unevenness also improved

# Improving Yarn Quality Tool 2: Combing

Rieter's toolbox for spinning recycled cotton ring yarns

## 1. Pre-carding / fine-cleaning

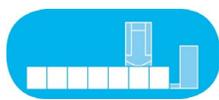
## 2. Combing

Description: Processing a blend of recycled and virgin fibers on a comber

Target: Removing the most disturbing short fibers / reduction of fiber neps

Waste: 10%

Pre-carding  
100% rCO

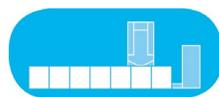


Bale opener

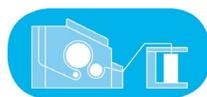


Card / Bale press

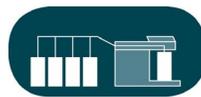
Spinning  
50% rCO / 50% CO



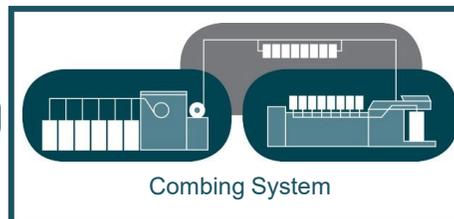
Blowroom



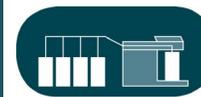
Card



Draw frame



Combing System



Draw frame



Roving frame



Ring spinning



Winder

Noil: 20%

# Improving Yarn Quality Tool 2: Combing

Pictures from combing preparation and E 90 combing production



50% CO / 50% rCO - OMEGAlap Feeding / creel



50% CO / 50% rCO - OMEGAlap Lap production



50% CO / 50% rCO E 90 Comber – During production



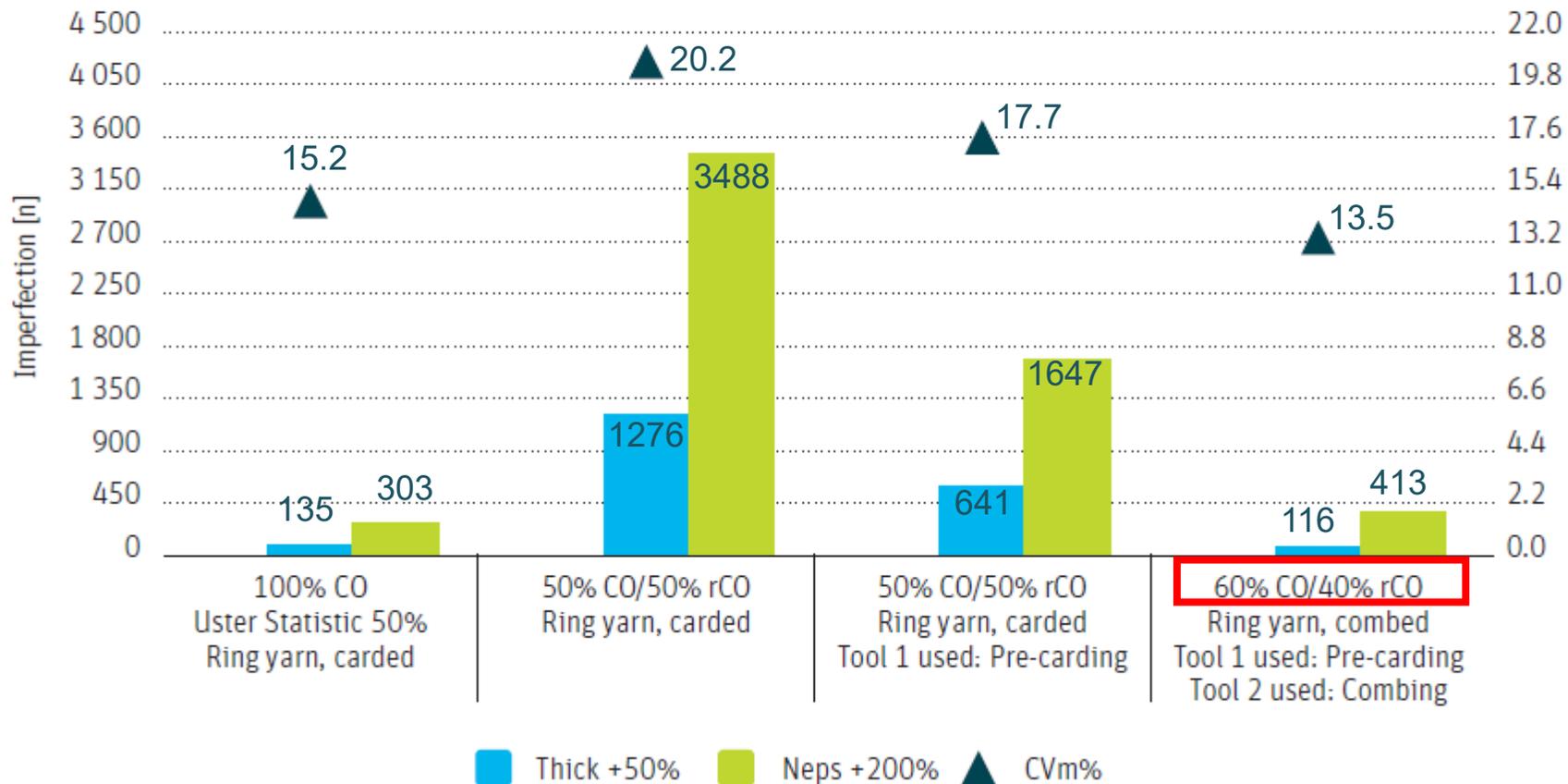
50% CO / 50% rCO E 90 Comber Combing Unit

# Results Including Tool 2: Combing

Pre-Carded Recycling fiber & combed 50/50 blend with virgin cotton

## Yarn Imperfections & CVm

Blend of cotton with mechanically recycled fibers (50%/50%), Ne 30



## Process

- 50/50 blend is produced in blowroom and processed on a comber
- Noil (in this case 20%) can be reused for rotor spinning (high amount of recycled content ~around 75%)
- Blend ratio changes to around 40% recycling and 60% virgin cotton

## Results

- Pre-Carding plus Combing delivers a reduction of thick places and neps of **around 90%** compared to reference carded sample

# Improving Yarn Quality Tool 3: Compacting

Rieter's toolbox for spinning recycled cotton ring yarns

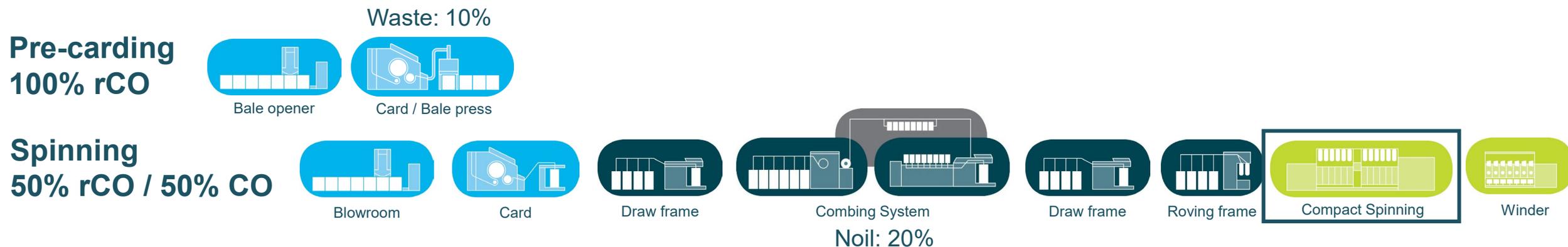
## 1. Pre-carding / fine-cleaning

## 2. Combing

## 3. Compacting

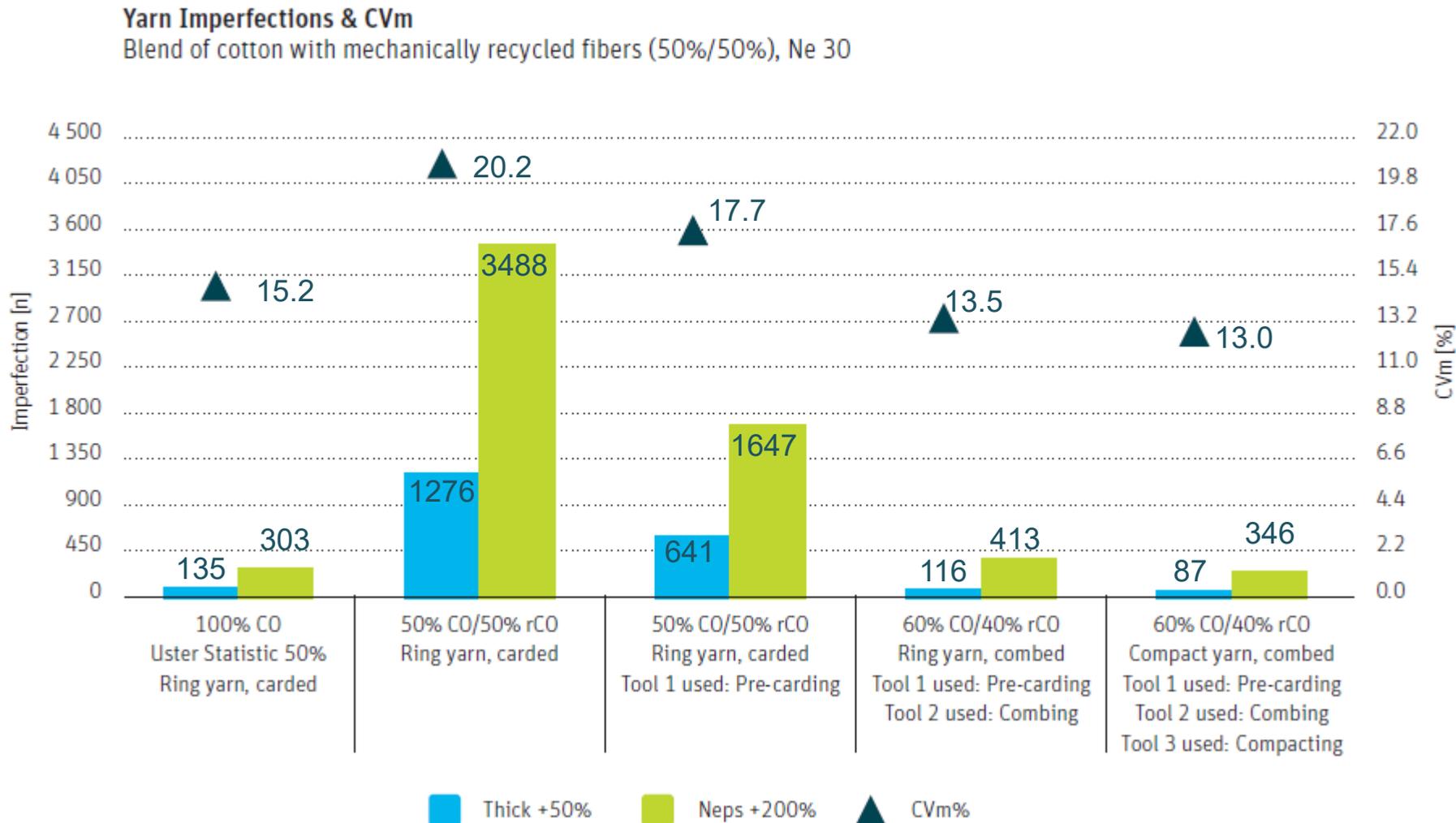
Description: Compacting on the ring spinning machine

Target: Increasing yarn tenacity / improving abrasion values



# Results Including Tool 3: Compacting

Pre-Carded Recycling fiber & combed 50/50 blend with virgin cotton



## Process

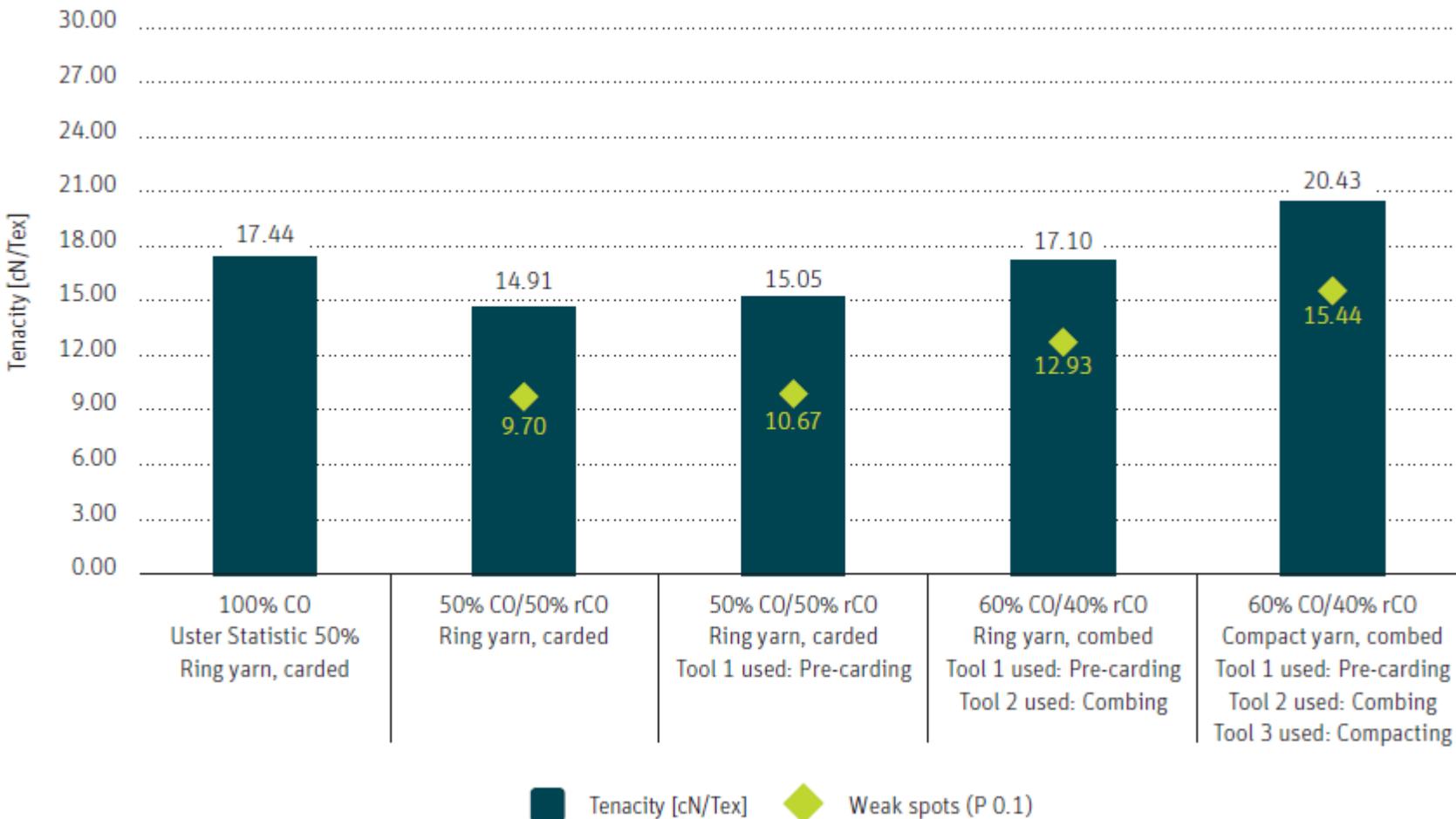
- Combination of pre-cleaning and combing and compacting (COMPACTdrum)

## Results

- Nep and thick place reduction of around 90% compared to reference sample
- **All values apart nep level reach better values than Uster Statistics for 100% CO, carded**

# Impact of the Three Tools on Yarn Tenacity

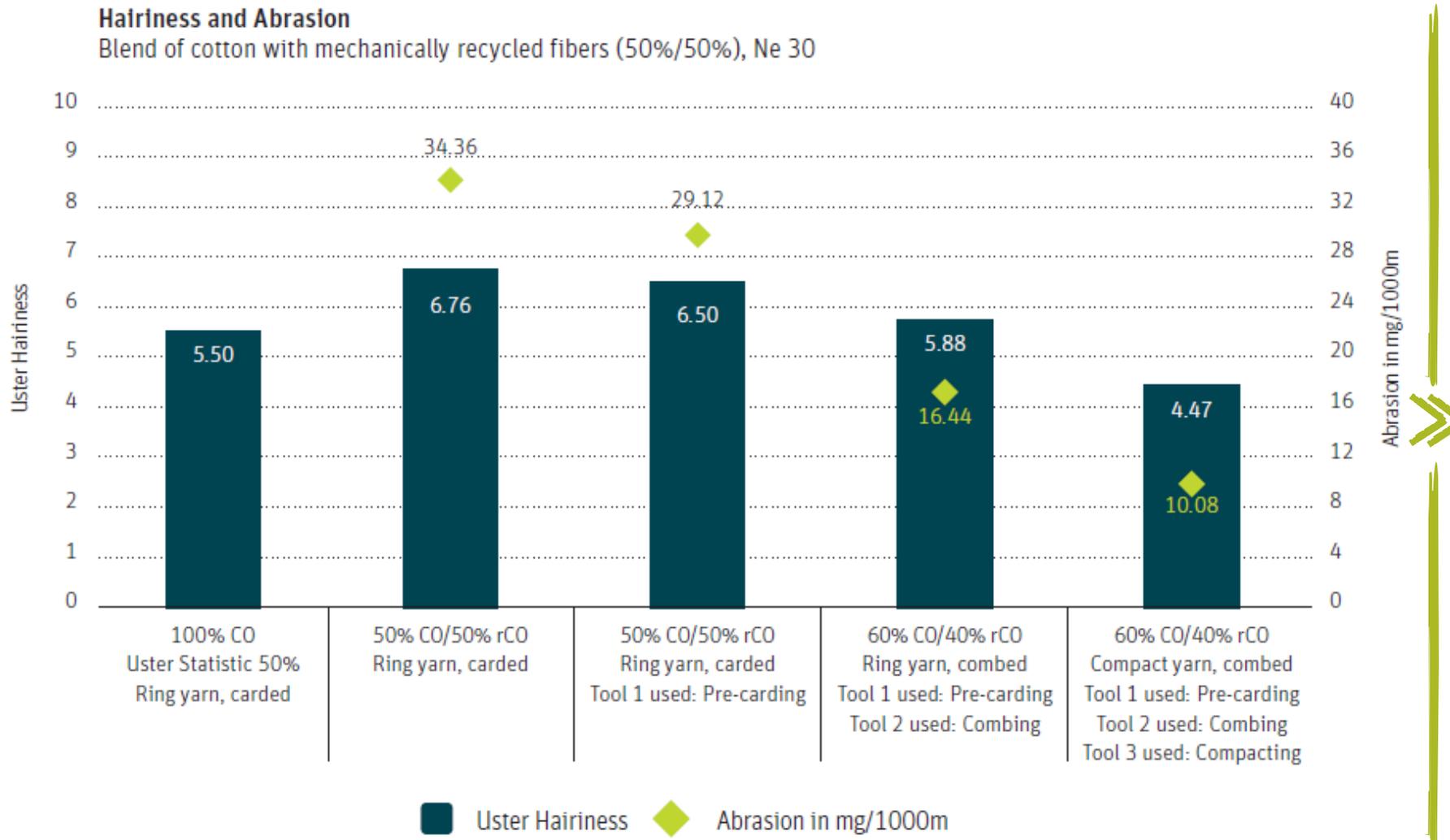
**Tenacity**  
Blend of cotton with mechanically recycled fibers (50%/50%), Ne 30



## Results

- **Pre-carding** has no influence on tenacity  
→ No impact of additional carding step (no fiber damage)  
→ No short-fiber removal on card
- **Combing** provides improved tenacity as most disturbing short fibers are removed in the process
- **Compacting** can increase tenacity by an additional 10 -20%

# Impact of the Three Tools on Hairiness and Abrasion



## Results

- **Pre-Carding** has only a minor influence on hairiness and abrasion
- **Combing** particularly improves the abrasion as more longer fibers are present in the blend which are not as easily removed as shorter fibers, also positive influence on yarn hairiness
- **Compacting** improves both, hairiness and abrasion significantly

## Conclusion

---

Achieving carded virgin cotton ring yarn quality with mechanically recycled fiber blends is possible

Three different measures to improve yarn quality as well as processability of recycled cotton blends were investigated

- Pre-carding
- Combing
- Compact

All three have shown the possibility to improve yarn results and spinnability significantly

A combination of the three measures enables spinning of high-quality ring yarns (up to Ne 30) with a high share of mechanically recycled cotton (depending on the raw material quality and yarn count)

## Our Actions

---

- Rieter offers the full rotor and ring spinning process for mechanically recycled fibers with specific recycling features
- In-depth know-how in the pre-processing and spinning of recycled fibers and available process toolbox which significantly improve the yarn quality and the running performance of the spinning process (pre-carding, combing, compacting or a combination of these)
- Close collaboration with key players and customers to further improve processability of mechanically recycled yarns
- Cooperation with chemical recyclers to share trends and conduct spinnability trials

**Com4** recycling-ring



**Com4** recycling-compact



**Com4** recycling-rotor



---

# Thank you

[Download Special Print - Combing of recycled cotton blends](#)

