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Influence of Machine Harvesting Methods on the Intermediates and End Product

Content

1 Introduction

Cotton dominates world short staple fibre mill consumption with more than 50 %. Optimisation in the yarn spinning process is an ongoing task. This study shall answer the question if the machine harvesting method has any influence on yarn quality. This is evaluated under a constant ginning process and with two different spinning technologies.

The study was made in close cooperation between Rieter, the leading manufacturer of spinning machinery offering all four most important staple fibre yarn technologies and the Cotton Institute of South Africa.

2 Overview of Cotton Production

In 2012, cotton production rose to a record level of 27 million tons per year. Man-made fibres primarily satisfy the increasing worldwide fibre demand.

Within the group of man-made fibres, synthetic fibres presently occupy first place with currently 18 million tons per year.

The production of fibres from renewable raw plant materials, which can be allocated to the category of the cellulose raw materials, already reached 4 million tons in 2012 and now in 2015 is close to 6 million tons although a great future growth potential still exists. (Figure 1)

The worldwide cotton cultivation is limited not only by the required area of land but also by the necessary water supply and the high proportion of herbicides, fungicides and insecticides. Agriculture accounts for 70 – 75 % of global water use and cotton's global water footprint is about 3 % of the world's agricultural water use. It is lower than many other commodities and proportional to cotton's land use of 2.3 % of the world's arable land.

The International Cotton Advisory Committee (ICAC) estimates that with current irrigation systems, today between 3 000 to 7 000 liters of water are needed to produce 1 kg of cotton lint fibre.

("Measuring Sustainability in Cotton Farming Systems"A report prepared by the ICAC Expert Panel on Social, Environmental and Economic Performance of Cotton Production in collaboration with the FAO Plant Production and Protection Division. Rome 2015.)

The most sparing and efficient method is drip irrigation which supplies the ground under the earth's surface with water. A drip irrigation, however, is very expensive and consequently only a maximum of 5 % of growers worldwide are today equipped with such an irrigation system.

World Production of Staple Fibre

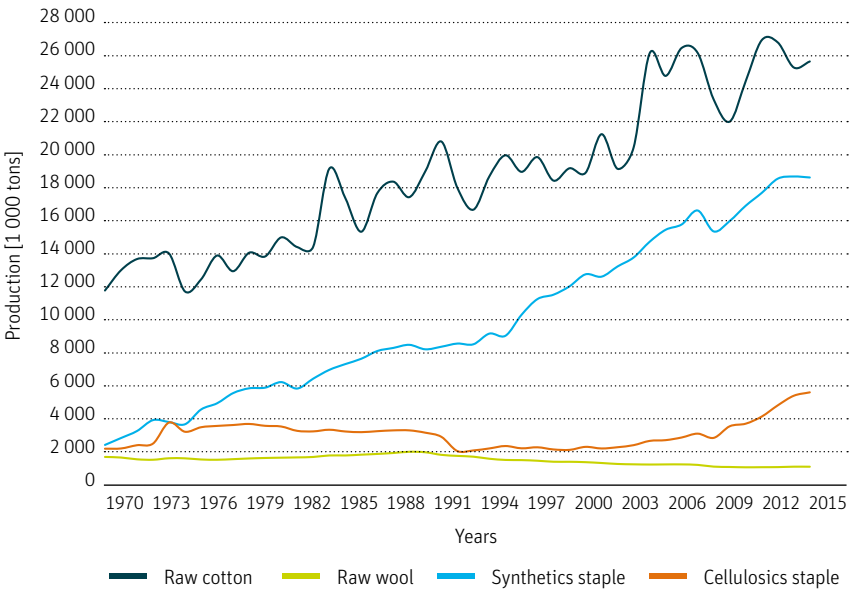


Fig. 1

Source: CIRF 2015, Technology RAS - XTP

To reduce the high application of chemicals and to thereby prevent groundwater contamination, bio-tech cotton today occupies a large share within the global production.

The share of BT cotton (bio technology cotton) resp. also GE cotton (genetically engineered) is increasing.

About 81 % of the world's cotton crop is grown with biotech varieties. In the USA it already amounts to 80 %, in China 70 % and in India 15 %.

Further countries that cultivate BT cotton are Argentina, Australia, Mexico, South Africa. Brazil, Burkino Faso, Colombia, Costa Rica, Myanmar, Pakistan, Paraguay and Sudan.

Manufacturers of such BT/GE cottons are, for example, SYNGENTA or MONSANTO and BAYER. With the GE cottons, a gene is incorporated which is intended to make the plant resistant to pests. This not only reduces the need for pesticides, but also the diseases caused by the cotton grower using pesticides. It results in a reduction to only 2 spraying cycles per year of cultivation. Unfortunately, these pest-resistant seeds are only supplied to the farmers at an annual charge (loyalty price). The old seeds from the previous year can no longer be used. The largest cotton producers worldwide are China and India followed by the USA, Pakistan and the CIS countries.

In Africa the cotton production in 2013 yielded about 1 400 000 tons, which is maximum 5 % of global production. In South Africa alone there was a production of 9 000 tons per year.

Currently the cultivation of cotton in Africa is practised in 26 countries. In the Cirfs Statistic, not all the production areas in Africa are shown. (Figure 2)

2.1. Cotton price

The cotton price varies according to market situation within the course of a year.

The growing demand over the years for the natural fibre, cotton, is also compensated via the rising price and by the use of man-made fibres. (Figure 3)

The Cotlook A price index is subjected to great price fluctuations. The Cotlook A index is a price index for raw upland cotton whose quality is above the level MIDDLING and is longer than 1 3/32". Cotlook B is used for coarser yarns and in terms of price accordingly lies below the price of Cotlook A or the CIF Index from Bremen.

On one hand, the cultivation area diminished and on the other hand, the yield also sank from 732 kg/ha to 712 kg/ha. To reduce fluctuations in the cultivation area, China has introduced a price system and now guarantees minimum prices which are above the international price level.

World Production of Staple Fibre

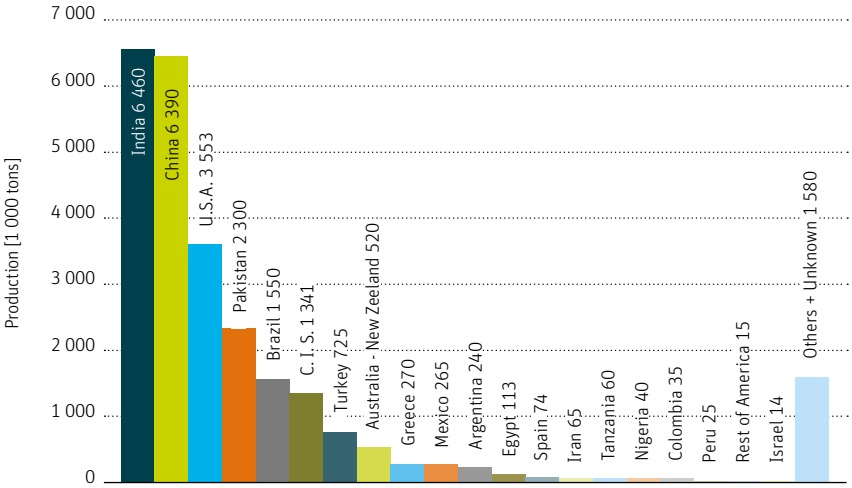


Fig. 2 Source: CIRF 2015, Technology RAS - XTP

Cotton Prices (1967-2015)
Various Cotton, Micronaire Group 5 (3.5 – 4.9 Micronaire)

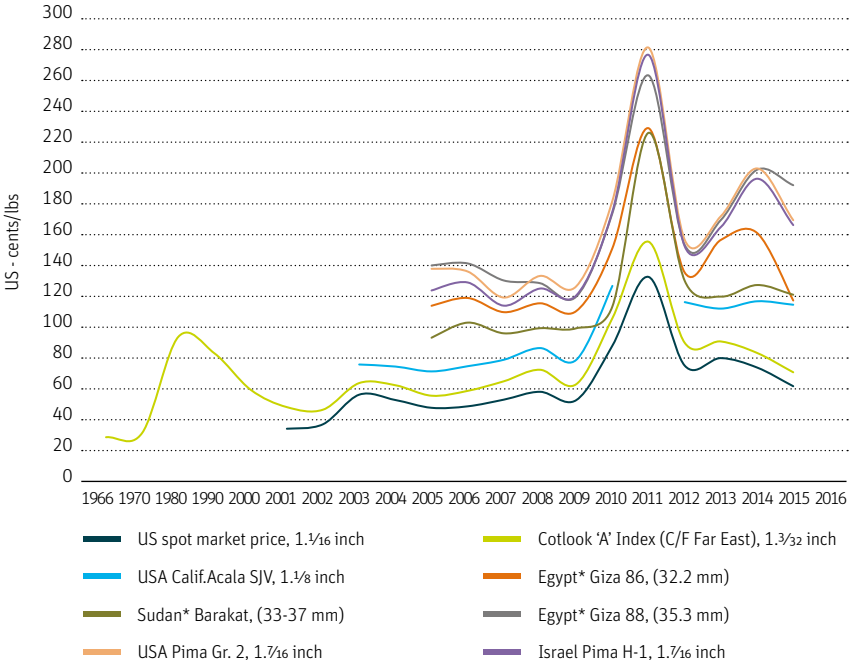


Fig. 3 Source: Bremer Cotton Report, Technology RAS-XTP

Cotton Prices (1967-2015)
1 3/32 inch, Micronaire Group 5 (3.5 – 4.9 Micronaire)

Fig. 4 Source: Bremer Cotton Report, Technology RAS-XTP

It remains to be seen what happens in the American market in this respect, as since 1st August 2006 the state subsidies to American farmers ($5 billion dollars per year) have been reduced due to objections from Brazil and Africa. (Figure 4)

Alongside the usual market influences on the cotton price, there is naturally also a massive relationship between fibre length and the cotton price.
The cotton price between a medium fibre length up to a long staple can easily be up to 3 times higher. (Figure 5)

Cotton Prices vs. Fibre Lengths
Various Cotton, Micronaire Group 5 (3.5 – 4.9 Micronaire)

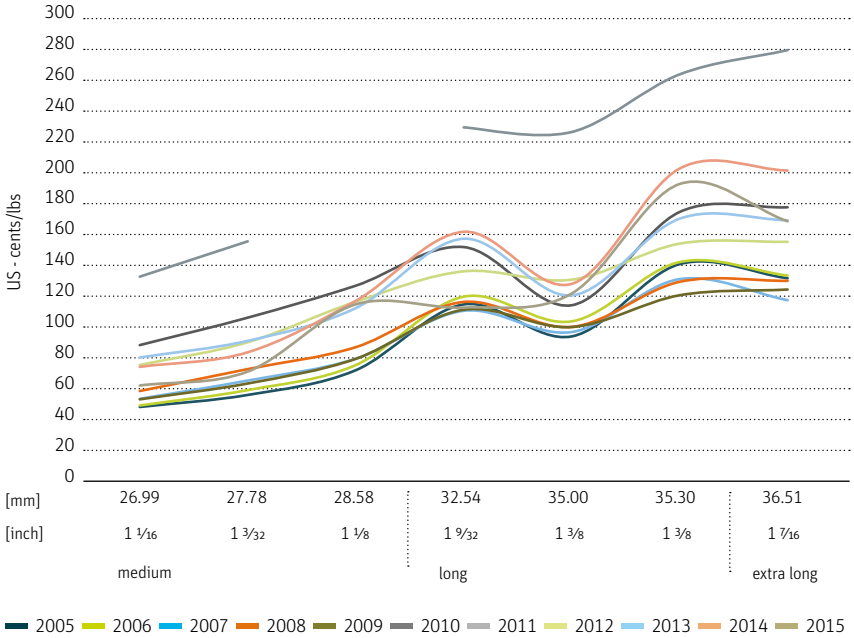


Fig. 5 Source: Bremer Cotton Report, Technology RAS-XTP

3 Machine Harvesting Methods

There are two types of machine pickers in use today. One is the “spindle” and one is the “stripper” picker. (Figure 6)

Harvest method

Cotton Picker Spindle, Type CP690 John Deere

Use of spindles, fingers or claws which gather the cotton from the opened bolls without damaging the leaves or the un-opened bolls

Cotton Picker Stripper, Type CP7460 John Deere

Modified stripper roll configuration with three bat and three brushes per stripper. Machine comb through the plants with prongs and gather the bolls.

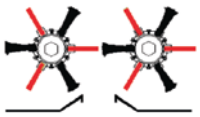


Fig. 6

Source: www.deere.com

The trash content of cotton picked with the spindle method is lower than with the stripper method. (Figure 7)

Harvest method

Cotton Picker Spindle | Cotton Picker Stripper

Fig. 7: The trash content of cotton picked with the spindle method is lower than with the stripper method

Source: www.deere.com

3.1. Spindle picker

It uses rows of barbed spindles that rotate at high speed and remove the seed cotton from the plant. The cotton seed is then removed from the spindles by a counter-rotating doffer and is then blown up into the basket.
Spindle pickers are supposed to pick cleaner cotton and are perceived to maintain better fibre quality characteristics. It is well known that with the spindle picking method, the seed coat content in the cotton is lower than with the stripper method.

3.2. Stripper picker

In response to increases in cotton production costs, producers are seeking ways to reduce input expenses, because brush using stripper methods are less expensive to operate than spindle harvesters. They also harvest cotton at higher speeds in high yielding cotton fields.

SASTAC in cooperation and with the support of Loskop Cotton Gin made it possible to import the first John Deere 7 460 cotton stripper into South Africa in order to evaluate and compare the stripper with the spindle focusing on differences in system efficiencies, harvesting and ginning costs as well as the impact on fibre and yarn quality.

Stripper harvesting has been designed for lower yield in dry land conditions which from a cost point of view seems to be a more suitable alternative harvesting method compared to spindle picker.

Stripper harvesters have several advantages over machine pickers of which the most important are the significantly lower purchase prices, fewer moving parts in the row units (“heads”) leading to lower fuel consumption and maintenance requirements. It also removes more cotton from the plant during the harvesting process but normally includes more immature cotton bolls which means the possibility of lower micronaire values can be expected. (Figure 8 – 10)

Fig. 8: Cotton stripper in operation Source: SA Cotton

Fig. 9: Cotton being stripped Source: SA Cotton

Fig. 10: Effective stripper harvesting Source: SA Cotton

3.3. Climatic conditions during the growing of the cotton before harvesting

Continuous drought conditions experienced before and after flowering had a negative effect on fibre length distribution and fibre strength.

Late cold spells on some of the farms also influenced the second stage of fibre formation which takes place when cellulose is deposited in successive layers on the inner surface of the primary wall after which some low micronaire (fibre fineness) cottons were identified.

Effective defoliation practices could not be maintained on all the farms due to the unfavourable weather conditions experienced which therefore also had a negative effect on the high trash content of the seed cotton.

Continued exposure to different weather conditions did have, in some cases, an effect on the white cotton in losing its brightness and becoming darker, varying from white to dull white cotton.

Different colour values are also the result of one picking process in which seed cotton bolls have been opened for some time and then mixed together with newly opened bolls.

4 Trial Conditions

4.1. Harvesting

Cotton production in South Africa is under threat and therefore the need for cheaper picking alternatives, especially for dry land produced cotton must be investigated.

For the purpose of this commercial trial, five farmers planted 870 hectares in the Springbok flats region to be stripper harvested.

In order to establish a uniform and disciplined approach in the Commercial Stripper Trial, practical guidelines were made available:

A
Timely and effective defoliation was needed with regard to the applicable cotton fields where the field stripper and picker exercise will take place. The crop has to be dry enough so that the bolls could be easily snapped and picked off the plant.

B
Before harvesting commences, representative samples of the involved cotton fields were picked by hand which will serve as a control measure for grade and fibre quality measurements before ginning.

C
Row unit maintenance and adjustments according to stripper harvester specifications must be ensured. Correct row adjustments and other maintenance procedures for the cotton picker should also be in place.

D
Correct level adjustment of stripping aggressiveness with the goal of harvesting the least foreign material was kept in mind for this study. Excessive harvest speeds should be avoided and must be adjusted to the prescribed rate of performance.

E
Care should be taken that factors influencing field cleaner performance and feed rates are addressed before harvesting commences.

F
Depending on climatic conditions, the seed cotton moisture content must be monitored before harvesting in order to avoid damaging fibre quality.

G
Care must be taken that the same field sizes are available for the stripper and spindle picking harvesting systems. The number of hectares harvested should also be monitored.

H
Representative seed cotton samples must be taken from both harvesting operations and after ginning, the applicable cotton lint samples of each lot must be presented to Cotton SA in order to determine any grade and quality differences that may occur.

I
Modules for stripper and spindle picked cotton must be weighed and ginned separately. Care should be taken to clear the gin stream / passages after each module representing the different harvesting methods before ginning of the next lot starts.

J
An analysis for the stripper and picker cotton included the following criteria:

- Yield means the seed cotton kg per hectare.
- Ginning outturn (GOT) with reference to % lint and seed turnout.
- Harvesting cost per hectare.
- Ginning cost per kilogram seed cotton.
- A complete quality profile of the cotton before and after ginning.
- A complete spinning analysis of the spindle and stripper cotton.

The cotton fields were exposed to the same weather conditions and stripper picked with the same machine, i.e. the John Deere eight-row 7 460 cotton stripper.

4.2. Ginning

All the cotton was afterwards ginned by Loskop Cotton under the same ginning conditions and operating with saw gins.

Foreign matter in seed cotton may include sticks, burrs, leaf, grass or other objects. Because of the indiscriminate manner in which stripper harvesters remove seed cotton from the plant, stripped cotton generally has more foreign matter than spindle picked cotton and will require more cleaning of the seed cotton especially during the precleaning stages of the ginning process.

No provision was made for additional pre-cleaning (inclined cleaner) equipment to cater for the stripper harvested seed cotton project. While the machinery specifications and sequences in each gin might differ, the main purpose in the ginning of the seed cotton is to preserve and protect the cotton's valuable fibre properties throughout the whole process in order to provide acceptable grades and qualities of cotton lint to the market place. Minimum loss of cotton lint during the ginning process is also of critical importance.

4.3. Spinning

Two different harvesting methods were each used by 2 different farmers.

The intermediate products in the spinning process were analysed which enables a far better interpretation of the yarn quality.

Two end spinning's were considered using 100 % cotton with a high short fibre content. With the ring and rotor spinning process, different yarn counts were spun to also see the impact on the yarn count.

The following yarn spinning plan was used.

Pos.	Machine	Type	Feed [tex]	Doubling [fold]	Draft [fold]	Delivery [tex]	Twist [T/m; T/"]	Delivery [m/min]	Production [kg/h] Speed [min^{-1}]	Remarks
CD-	Card	C 70				5 400		263	85	
DB-	Drawframe	SB-D 15	5 400	6	6.5	5 000		600		
DC-	Drawframe	RSB-D 45	5 000	6	6	5 000		500		
FA-	Roving	F 15	5 000	1	6.77	738.5	45			Max. 1 100
GA-20	RSM	G 36	738.5	1	25.0	29.55	740		150 000	Ne 20 æ 4.2
GA-24	RSM	G 36	738.5	1	30.0	24.63	810		150 000	Ne 24 æ 4.2
GA-30	RSM	G 36	738.5	1	37.5	19.7	906		150 000	Ne 30 æ 4.2
RA-24	Rotor	R 60	5 000	1	203.0	24.63	810		125 000	Ne 24 æ 4.2
RA-30	Rotor	R 60	5 000	1	254.0	19.7	906		140 000	Ne 30 æ 4.2

5 Results of Ginning

5.1. The turn out of ginning

Ginning turnout (GOT) is a measure of the mass of lint per unit mass of the seed cotton entering the gin. The influence of the foreign matter content of seed cotton, the number of stages of cleaning, and the variety (which primarily affects the mass of seed per unit mass of lint) play an important role in determining the final ginning outturn.

Significant differences were detected in lint turnout between the stripper machine-harvested in comparison to spindle picked seed cotton. In order to determine the GOT of the various samples obtained from all the different locations, a laboratory saw gin was used.

From two locations, the lint obtained from the stripper cotton compared to the spindle picked cotton was considerably lower. The impact of the higher trash / visible trash content with regard to the stripper cotton on the final GOT results was quite clear.

The GOT results based on the stripper and spindle picked seed cotton on average amounted to 30.5 % compared to the +/- 35 % lint turnout of the spindle picked cotton. (Figure 11)

Turnout of Ginning Depend of Different Farmer and Harvesting
100 % Cotton

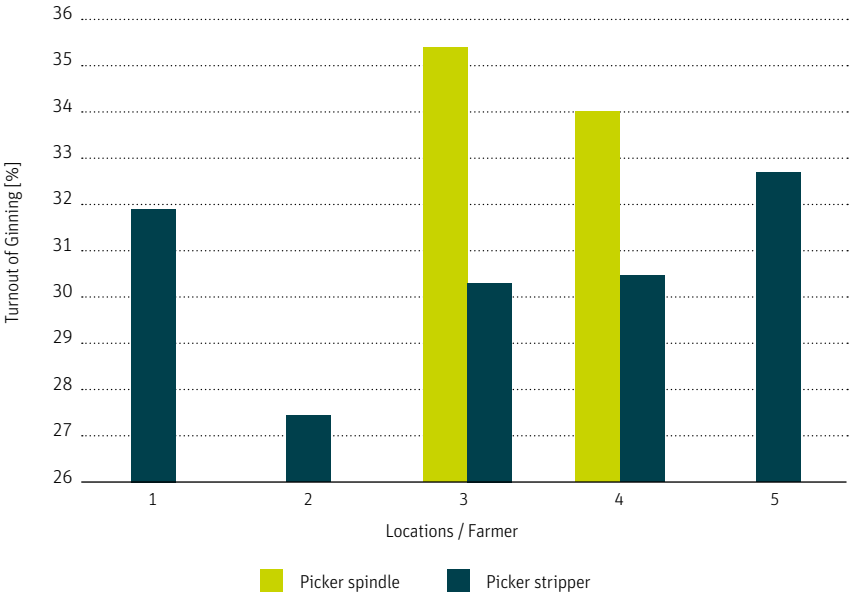


Fig. 11 Source: Cotton of South Africa, Technology RAS-XTP

5.2. Fibre quality after ginning in bale

5.2.1. Lint content

The lint content and trash show no clear trend between spindle and stripper yield method using the tester from ITV. Furthermore, the huge difference in raw material from farmer 2 shows that there must be another parameter other than spindle or stripper which has an influence on the lint content. (Figure 12)

Influence of Harvest Methode Spindle and Stripper, Cleanness
100 % Cotton, ITV Trashtester TT2000

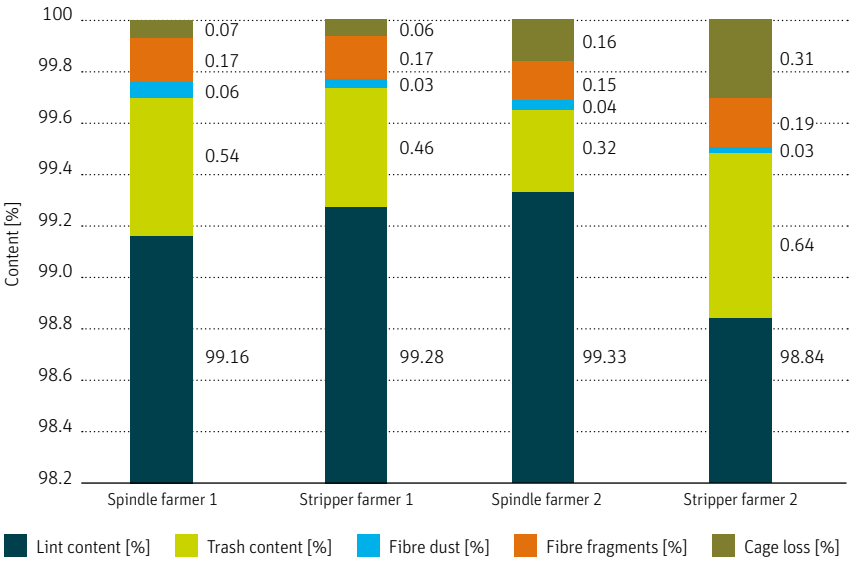


Fig. 12 Source: RAS-XT / RAS-XTP Technology TIS 26807

The lint content shows a positive trend for spindle picking using the Selecter tester. So the lint content with spindle is about 0.3 – 0.7 % higher. (Figure 13)

5.2.2. Fibre fineness

Despite using the same farmer, and especially the cotton from farmer 2, a significant difference in the fibre fineness was shown. That means that some yarn results, like evenness or strength, can be influenced by these criteria. It is not clear why the gap in fibre fineness from the same farmer can be so significant. (Figure 14)

Spindle harvesting shows lower neps than stripper harvesting. The higher the leaves and trash content is, the higher the cleaning work and the risk of creating fibre neps. Due to the situation that the ginning was kept constant, we must conclude that spindle harvesting has created fewer neps in comparison to stripper harvesting.

Influence of Harvest Methode Spindle and Stripper, Cleanness
100 % Cotton, Selecter

Fig. 13 Source: RAS-XT / RAS-XTP Technology TIS 26807

Influence of Harvest Methode Spindle and Stripper, Fibre Fineness
100 % Cotton, HVI

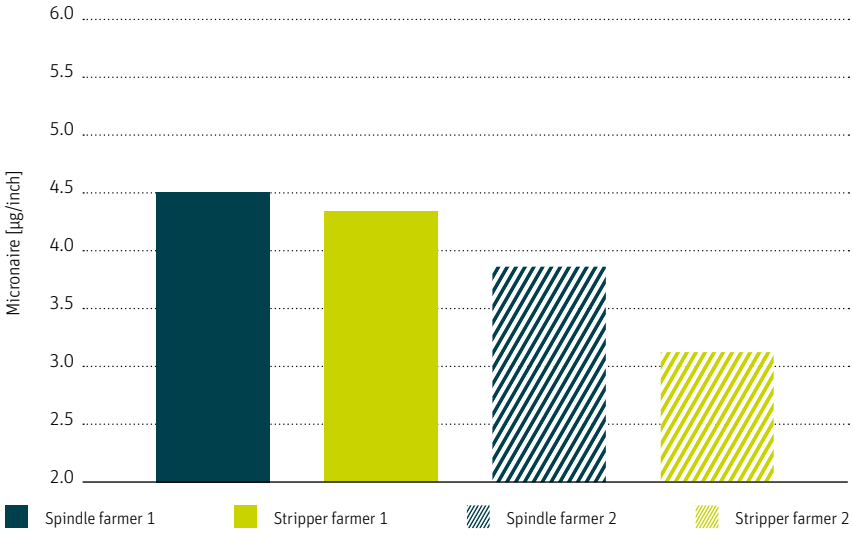


Fig. 14 Source: RAS-XT / RAS-XTP Technology TIS 26807

5.2.3. Neps and trash

Trash content shows no clear difference in bale between spindle and stripper method or farmer. (Figure 15)

The seed coat fragments size is very much influenced by the ginning method. Saw ginning has a far more negative effect than roller ginning. Due to the situation that ginning was the same in every position, the stripper method results in slightly smaller seed coat nep size which means that the stripper appears slightly more aggressive than the spindle. For the spinning process, it is not an advantage because it is far more difficult to clean a smaller seed coat size than a bigger size. Anyway the influence of the farmer is higher than the influence of harvesting. (Figure 16)

Long fibres (> 5 %) are longer with spindle harvesting, independent of the raw material, and result also in 1 – 2 mm higher commercial staple. (Figure 17)

Influence of Harvest Methode Spindle and Stripper, Neps and Trash
100 % Cotton, AFIS

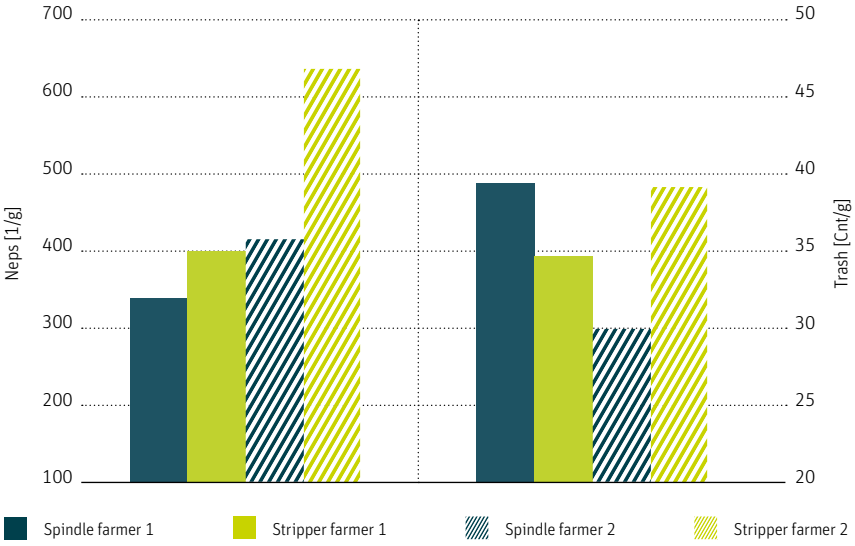


Fig. 15

Source: RAS-XT / RAS-XTP Technology TIS 26807

Influence of Harvest Methode Spindle and Stripper, Seed coat Neps
100 % Cotton, AFIS

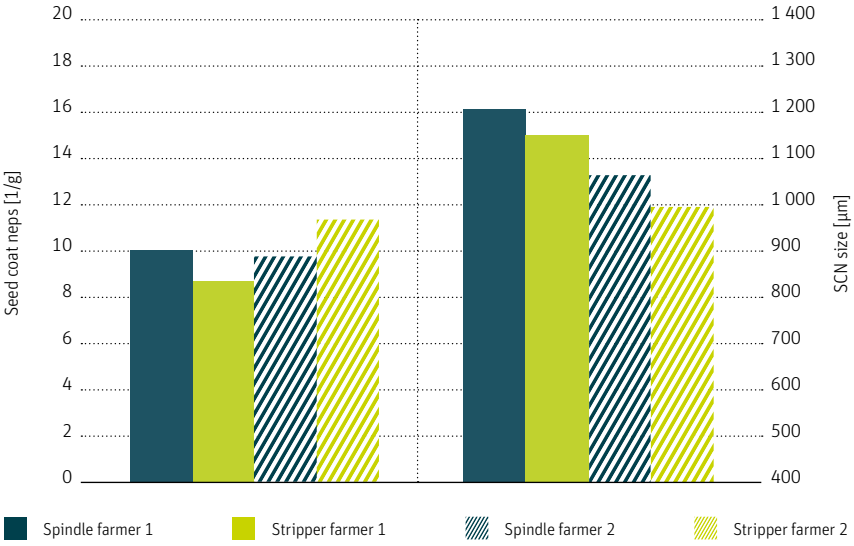


Fig. 16

Source: RAS-XT / RAS-XTP Technology TIS 26807

5.2.4. Fibre length

Middle staple is 1 - 2 mm higher with the spindle method than with the stripper method.

If the ginning was the same on each trial position, the stripper has therefore created more fibre stress or in the ginning more intensive cleaning was used due to higher leaf content.

Nevertheless, with the stripper yield method the fibre stress is higher and therefore the middle staple mm lower.

We cannot say that there are general and significant disadvantages using the stripper method worldwide, but if a real loss of 1 – 2 mm staple length occurs with the middle staple, it will have a negative influence on the yarn spinning process. (Figure 18)

Influence of Harvest Methode Spindle and Stripper, Fibre Length
100 % Cotton, AFIS

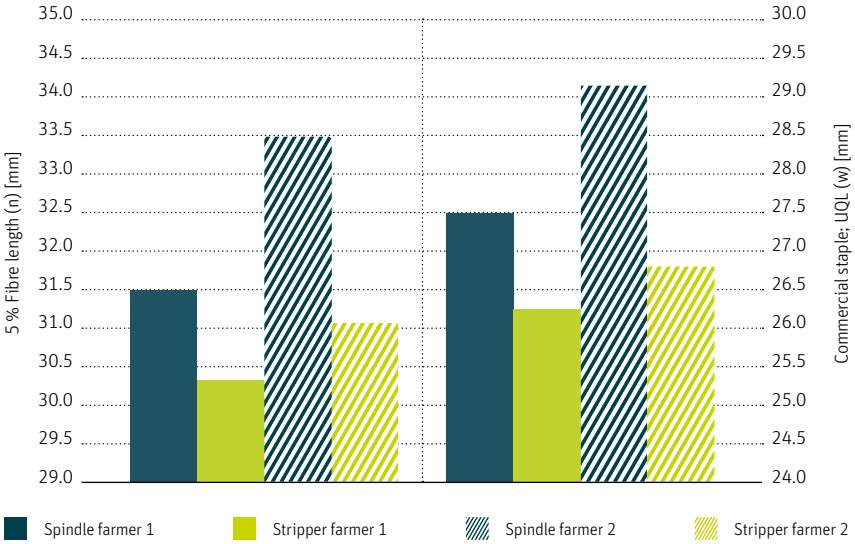


Fig. 17

Source: RAS-XT / RAS-XTP Technology TIS 26807

Influence of Harvest Methode Spindle and Stripper, Fibre Length
100 % Cotton, AFIS

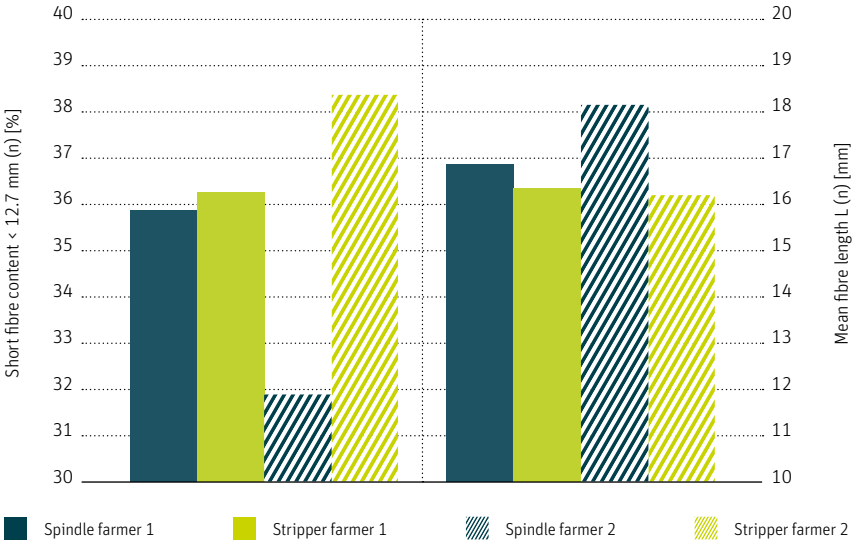


Fig. 18

Source: RAS-XT / RAS-XTP Technology TIS 26807

5.2.5. Fibre strength and elongation

Spindle harvesting also provides higher strength after ginning. (Figure 19)

5.2.6. Cleaning ability

The machine harvesting method, but also the more aggressive saw ginning compared to roller ginning, has a great influence on the cleaning ability of the cotton in the subsequent spinning process.

The ginning strongly determines the residue trash content and the type of trash content, for example, seed coat fragments. Establishing the characteristic cleaning curve is therefore a possibility to illustrate the cleaning ability and this enables better preparation of the cleaning process to be made.

The steeper the rise of the individual cleaning stages, the higher is the cleaning ability of the cotton.

No difference is found in the cleaning ability between spindle and stripper.

The influence of the farmer is, however, visible.

The cotton from farmer 1 has a somewhat better cleaning ability than that from farmer 2. (Figure 20)

Influence of Harvest Methode Spindle and Stripper, Fibre Strength and Elongation
100 % Cotton, HVI

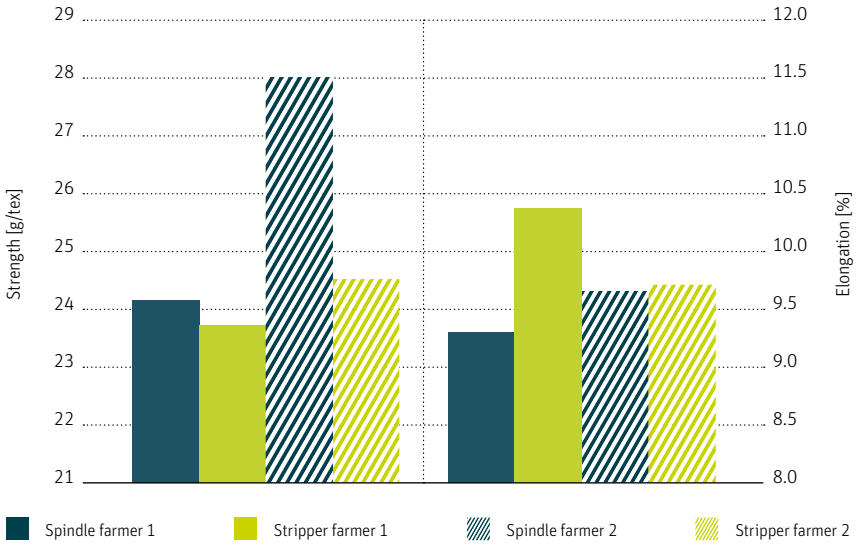


Fig. 19

Source: RAS-XT / RAS-XTP Technology TIS 26807

Cleaning Ability Trash
100 % Cotton, ITV Trashtester TT2000

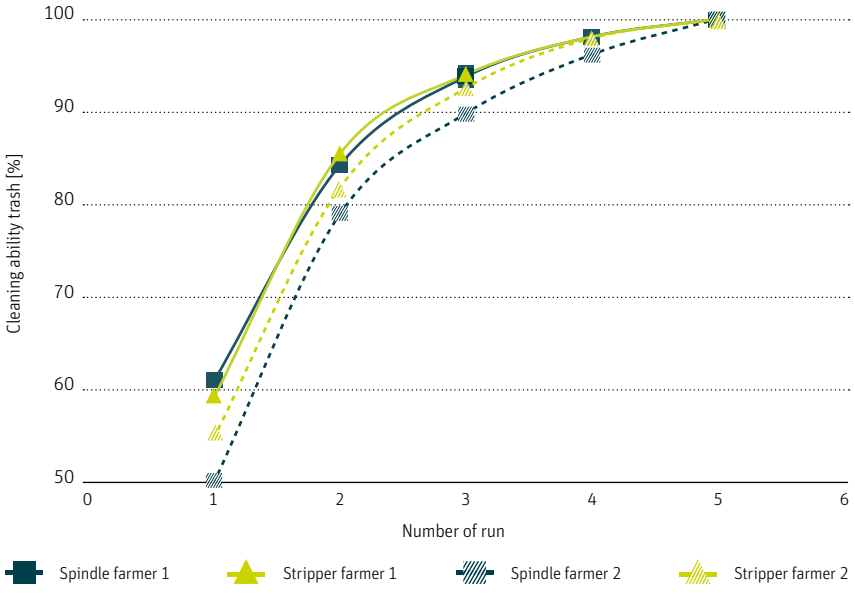


Fig. 20

Source: RAS-XT / RAS-XTP Technology TIS 26807

The results after ginning show a positive trend for spindle picking for all the following criteria: (Figure 21)

Overview Cotton Analyse in Bale

	Spindle in comparison to stripper	Farmer 1 in comparison to farmer 2
Ginning turn out	Clear more = clear better	slightly lower = slightly worse
Trash	no clear difference	no clear difference
Neps	less	less
Seed coat fragments size	slightly bigger	bigger
Long fibre 5 % staple and commercial staple	higher	slightly higher
Short fibre content	lower	No clear difference
Middle staple	higher	No clear difference
Fibre strength	higher	slightly lower
Cleaning ability	same	higher

Fig. 21

6. Results of Fibre Quality in the Spinnning Process

Checks on fibre quality in the fibre preparation are additionally helpful to weighting the ginning quality and for the later interpretation of yarn endspinning through to the textile fabric quality.

6.1. Trash over the fibre preparation

The trash content over the process stages confirms the measurements already made in the bale after the ginning process.

There is no clear difference between spindle and stripper and no clear difference from farmer 1 to 2 up to the carding entrance.

After the carding machine and due to the excellent cleaning degree in carding, there will no longer be any difference in the carded sliver in the following process stages.

So trash content in the bale is primarily a question of carding load and lifetime of the clothing's. (Figure 22)

As is usual in all studies we have done, it is obvious that the best degree of cleaning is realised by the coarse cleaner and carding process. There is no influence originating from harvesting method and farmer. (Figure 23)

Trash Content vs Process Stages
100 % CO, ITV Trashtester TT2000

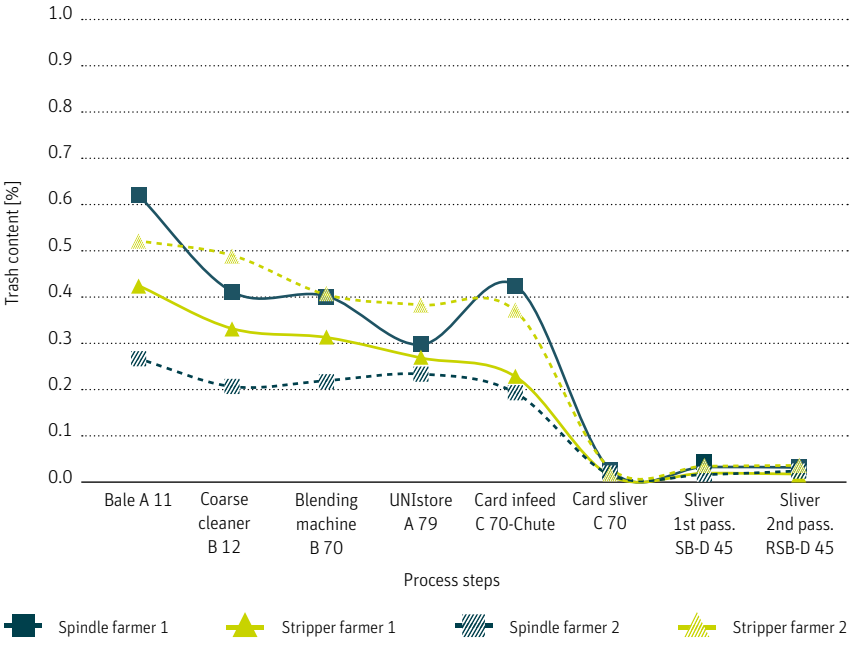


Fig. 22 Source: RAS-XT / RAS-XTP Technology TIS 26815

Trash Content vs Process Stages
100 % CO, ITV Trashtester TT2000

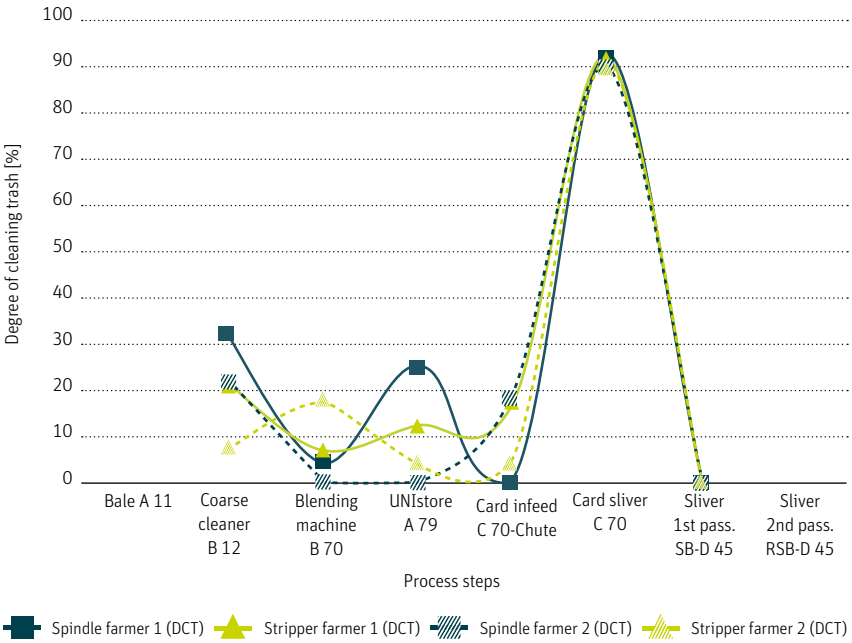


Fig. 23 Source: RAS-XT / RAS-XTP Technology TIS 26815

6.2. Neps over the fibre preparation

A clearly higher nep level in the bale will also result in a higher nep level to the card sliver and the further process stages. Stripper harvesting in combination with cotton from farmer 2 has a significantly higher nep level. A higher nep level is also influenced by the fibre fineness. The results in the bale already show that stripper harvesting from farmer 2 has a micronaire of 3.17 which is very fine.

The finer the fibre with a constant fibre length, the higher will be slenderness and therefore the nep formation.

The finer the fibre the more positive is the spindle method regarding lower neps. (Figure 24)

Neps vs Process Stages
100 % CO, AFIS

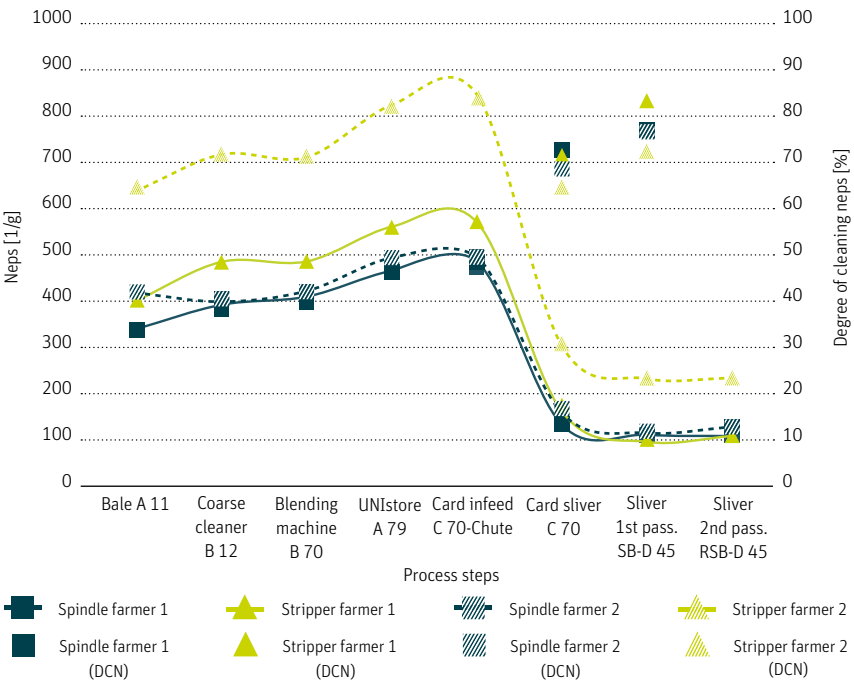


Fig. 24 Source: RAS-XT / RAS-XTP Technology TIS 26815

6.3. Fibre length over the fibre preparation

The longer fibre of 1 – 2 mm in the 5 % staple length using spindle harvesting could be confirmed over all fibre preparation process stages.

Farmer 1 has about 0.5 – 2 mm less long fibre compared to farmer 2. (Figure 25)

With spindle harvesting, before as well after carding, the short fibre content is about 6 % lower than with stripper harvesting using the cotton from farmer 2. This despite the fact that the fibre from farmer 2 has more fibre strength and fine fibre.

Using the cotton from farmer 1, there is no clear difference between spindle and stripper.

It was supposed that due to the lower strength and coarse fibre, using this fibre-type, the spindle harvesting should especially here shown a positive effect.

Fibre Length vs Process Stages
100 % CO, AFIS

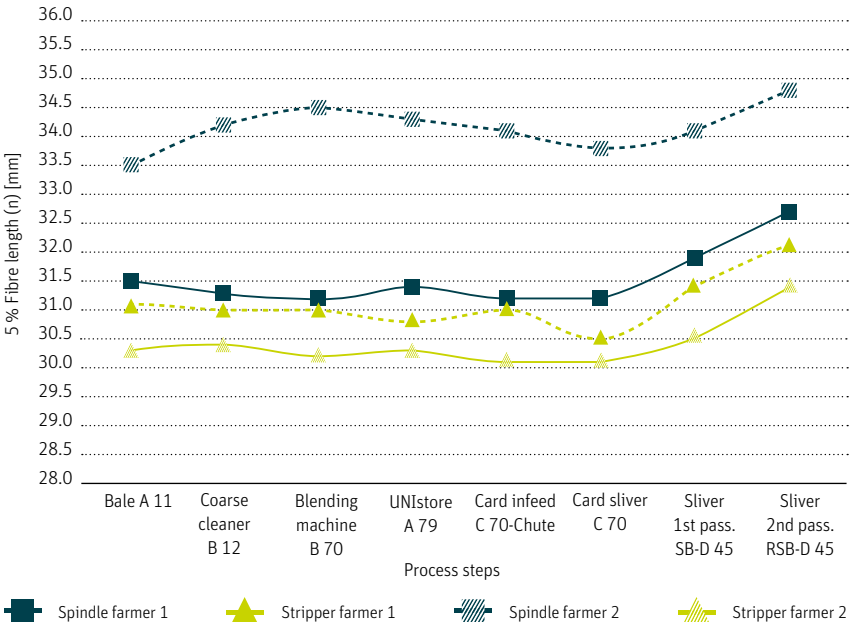


Fig. 25 Source: RAS-XT / RAS-XTP Technology TIS 26815

However, this is not the case. So the reason why with both farmers the positive effect of spindle harvesting can not be seen is not clear. (Figure 26)

The short fibre content influences the middle staple and the middle staple is a very good indication and confirmation of the short fibre content. So it make sense, if both of these criteria's are checked together. Over the process line, it can be seen that the middle staple using spindle harvesting with both farmers is higher than the stripper harvesting.

The middle staple length is about 1 – 2 mm longer with spindle.

Using the stripper harvesting there is no difference visible in the middle staple between farmer 1 and farmer 2. (Figure 27)

6.4. Waste over the fibre preparation

The waste amount in total during the spinning process with spindle harvesting is about

1 – 1.5 % lower in comparison with stripper harvesting.

Farmer 1 shows about 1 – 1.5 % higher waste than farmer 2. (Figure 28)

Fibre length vs Process Stages
100 % CO, AFIS

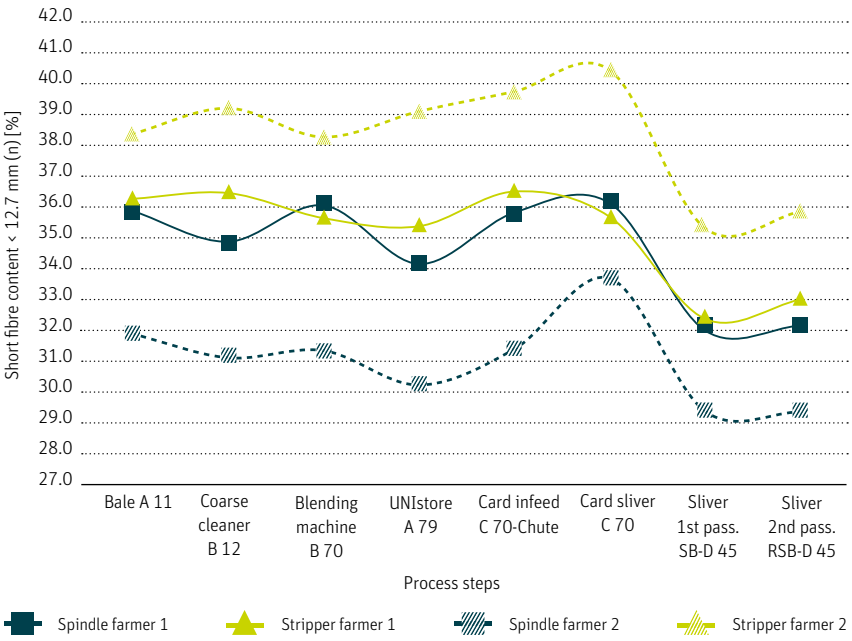


Fig. 26 Source: RAS-XT / RAS-XTP Technology TIS 26815

Fibre Length vs Process Stages
100 % CO, AFIS

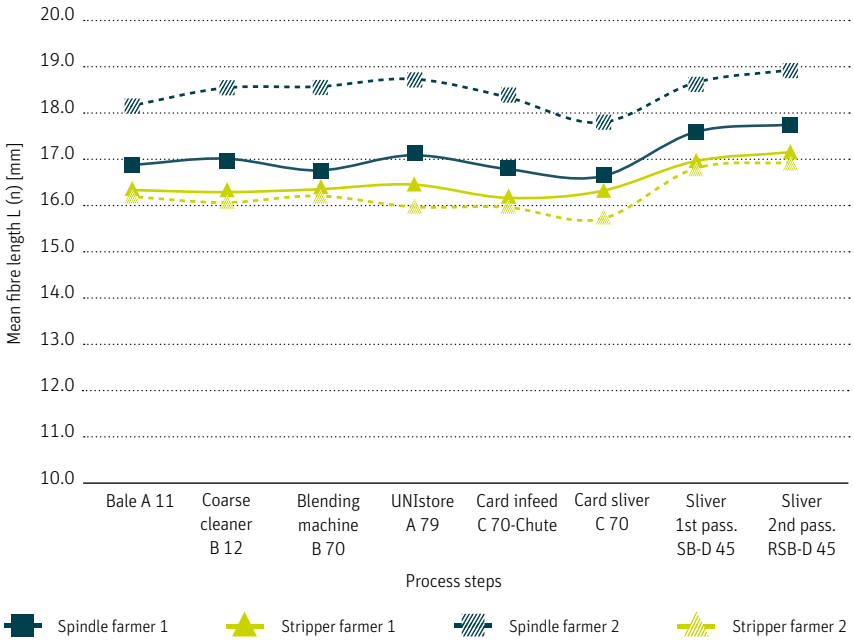


Fig. 27 Source: RAS-XT / RAS-XTP Technology TIS 26815

6.5. Sliver and roving evenness over the fibre preparation

Using the cotton from farmer 2, the spindle harvesting shows about 0.7 % better CVm in comparison to stripper harvesting. But there is no difference between harvesting using the cotton from farmer 1. The cotton from farmer 2 results in a better CVm of 0.5 – 1 %, than farmer 1. (Figure 29)

The findings regarding roving evenness can be realised in the shorter test length of 1 cm = CVm %.

The longer the test length, the more equal the roving.

Waste vs Process Stages
100 % CO

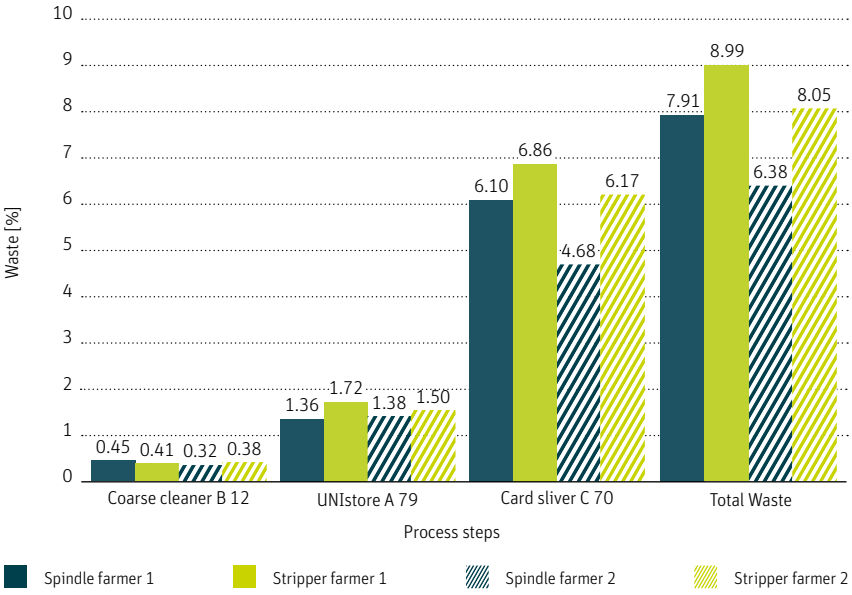


Fig. 28

Source: RAS-XT / RAS-XTP Technology TIS 26815

Evenness vs Process Stages
100 % CO, UT4

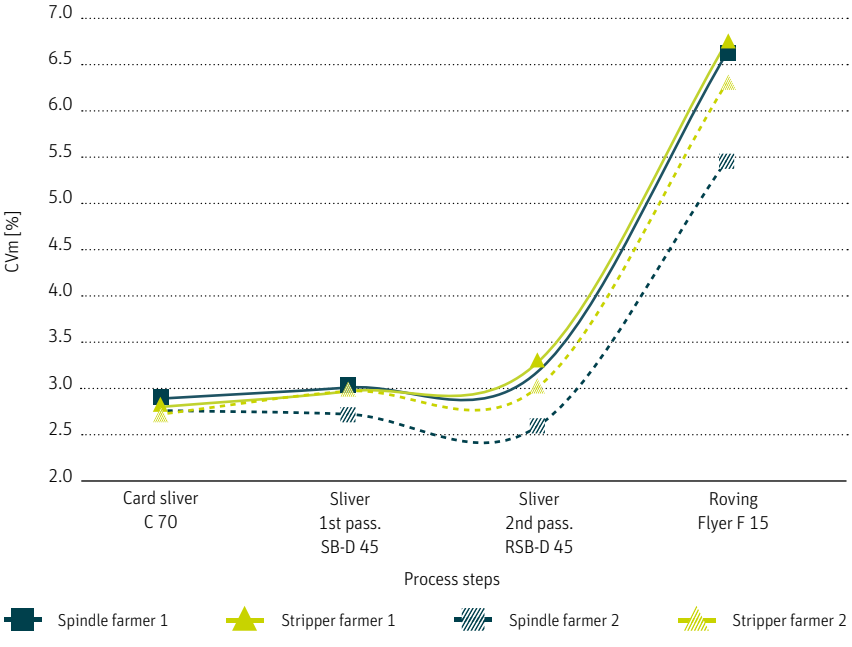


Fig. 29

Source: RAS-XT / RAS-XTP Technology TIS 26815

With a test length of already 1 m, no difference exists between the trial samples. (Figure 30)

Spindle harvesting shows the following results after the fibre preparation. (Figure 31)

Influence of Harvest Method Spindle and Stripper, Evenness Roving
100 % CO, UT4

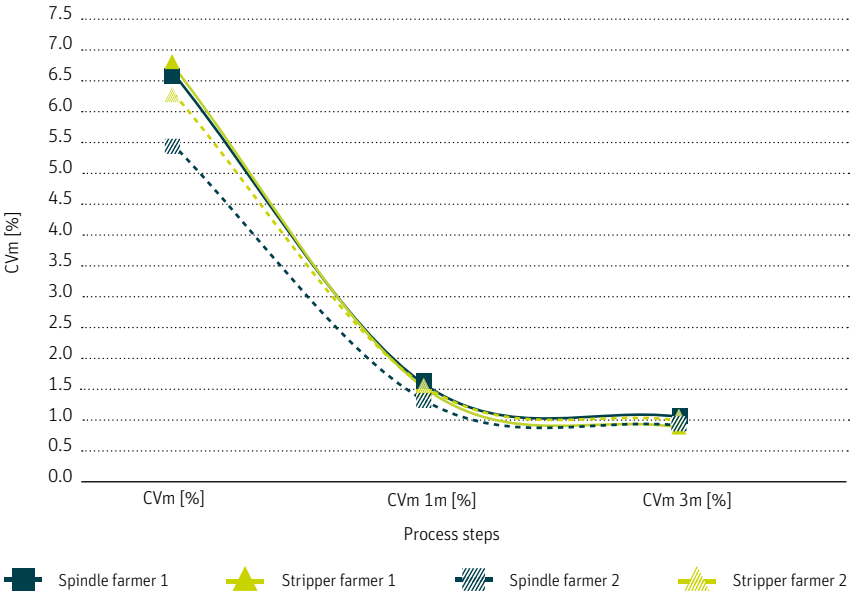


Fig. 30

Source: RAS-XT / RAS-XTP Technology TIS 26815

Overview Cotton Analyse, Intermediate Product

	Spindle in comparison to stripper	Farmer 1 in comparison to farmer 2
Trash	same after carding	same after carding
Neps	less	less
Long fibre 5 % staple	higher	less
Short fibre content	same or lower	no clear influence
Middle staple	higher	no clear influence
Waste over the process stages	lower	higher
Roving Evenness	same or better	worse

Fig. 31

7 Results of Yarn Quality Using Ring and Rotor Yarn

7.1. Yarn evenness

A higher middle staple length and lower short fibre content using the spindle harvesting must have a positive effect on the yarn evenness. With the cotton from farmer 2, it can be confirmed that with the spindle method we reached a better evenness than with the stripper method.

Unfortunately, using the cotton from farmer 1 clearly shows the opposite.

Detailed clarifications such as repetition in raw material testing and yarn spinning show the same results. Therefore, the test results between spindle and stripper from farmer 1 must be rated as the same.

The cotton from farmer 2 shows a better evenness compared with farmer 1. (Figure 32)

As far as rotor yarn is concerned, there is no clear indication of the influence of spindle and stripper regarding evenness. This was expected due to the situation that the structure of a rotor yarn has a much higher influence on evenness than the method of harvesting.

Nevertheless, the influence of the raw material on the yarn evenness stands out whereas the raw material from farmer 2 was approx. 0.5 CVm % better in absolute terms than from farmer 1.

Another important finding which emerges is that the rotor yarn shows a clearly better evenness in the yarn than the ring yarn. This is not a general effect. As soon as the short fibre content is very high, the rotor spinning machine can control the fibre far better than the drafting zone on the ring spinning machine. The limit where the rotor spinning machine obtains a better evenness in the yarn is

Influence of Harvest Method Spindle and Stripper, Yarn Evenness
100 % CO, Com4®ring, 4.2αe, 15 000 min^{-1}, 40 mm ring diameter

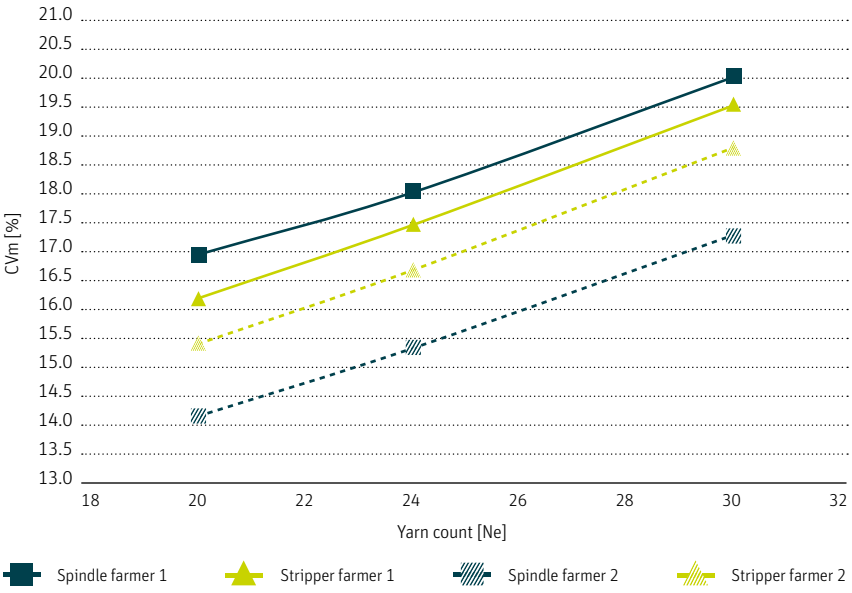


Fig. 32 Source: RAS-XT / RAS-XTP Technology TIS 26815

Influence of Harvest Method Spindle and Stripper, Yarn Evenness
100 % CO, Com4®rotor, 4.2 αe, 28 mm rotor diameter

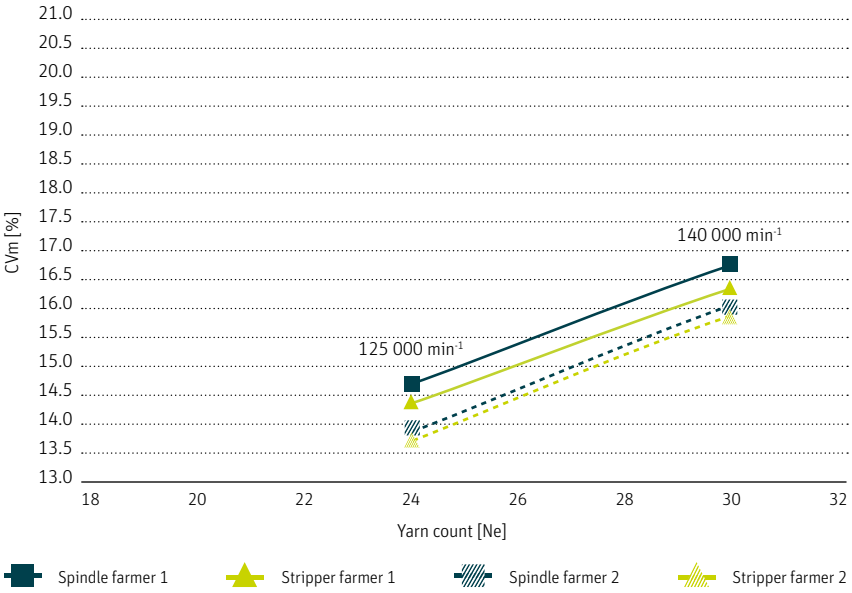


Fig. 33 Source: RAS-XT / RAS-XTP Technology TIS 26815

when the short fibre content is the same or more than approx. 30 %.

With Ne 30 it was reached at a rotor speed of 140 000 rpm.

For both rotor speeds and yarn counts, the 28 mm rotor diameter was used.

That means that we recommend using such a cotton for the rotor spinning process rather than the ring spinning process, in the case where the yarn can only be carded.

If the cotton is used for the ring spinning system, we recommend using the combing process for ring yarn to comb out the short fibres to reach the requirements the customer normally has for such a ring yarn count. (Figure 33)

7.2. Yarn neps

The nep level results show a similar effect to the ones for evenness.

Using the cotton from farmer 2, the spindle harvesting shows a better trend than the stripper. On the other hand, using the cotton from farmer 1 shows the opposite. (Figure 34)

The rotor yarn shows more neps with spindle harvesting than with stripper harvesting. (Figure 35)

Influence of Harvest Method Spindle and Stripper, Imperfection
100 % CO, Com4®ring, 4.2αe, 15 000 min^{-1}, 40 mm ring diameter

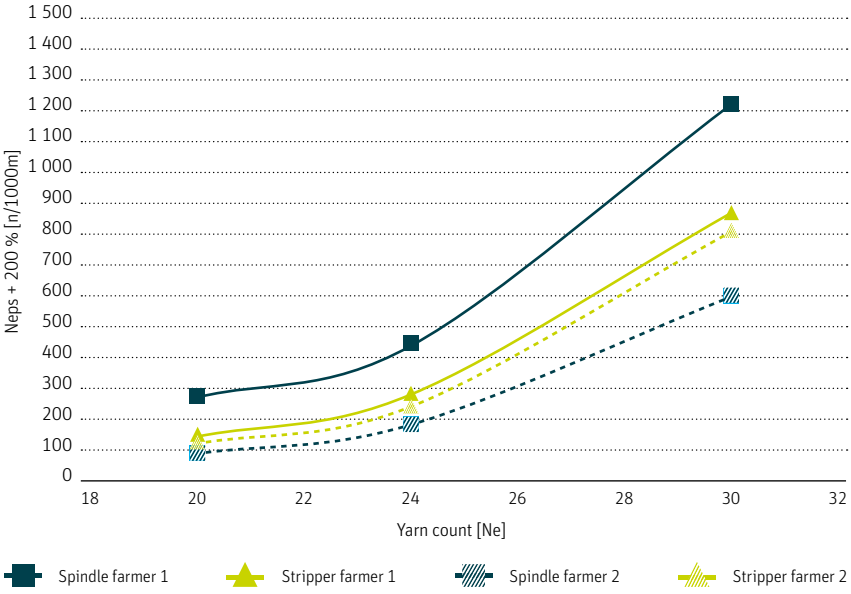


Fig. 34 Source: RAS-XT / RAS-XTP Technology TIS 26815

Influence of Harvest Method Spindle and Stripper, Imperfection
100 % CO, Com4®rotor, 4.2 αe, 28 mm rotor diameter

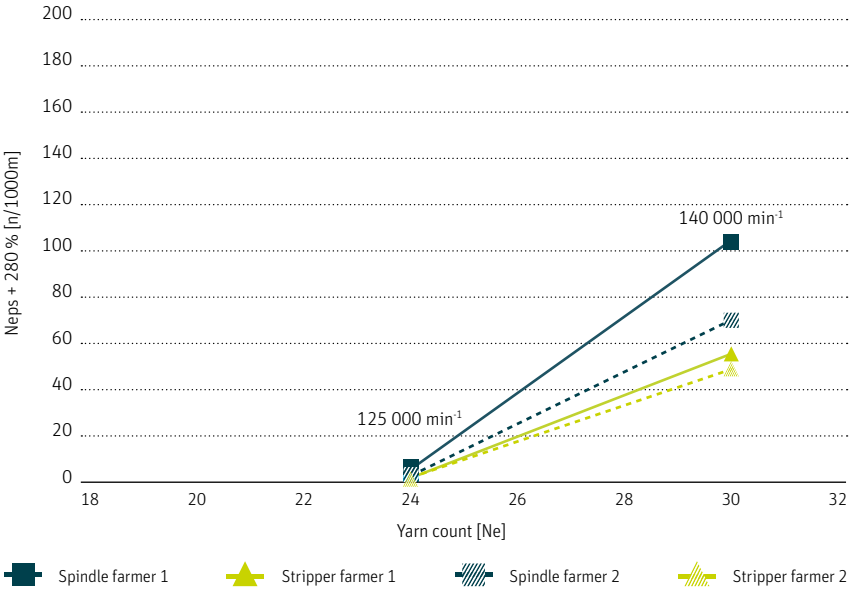


Fig. 35 Source: RAS-XT / RAS-XTP Technology TIS 26815

7.3. Yarn strength and elongation

The yarn strength shows here a clearer picture than the evenness.

Spindle harvesting, independent of the cotton farmer, results in a higher yarn strength.

So the yarn strength with spindle harvesting ranges from 0.5 cN/tex to 1.5 cN/tex higher than with stripper harvesting. The cotton from farmer 2 results in 1.5 cN/tex to 2.5 cN/tex higher yarn strength than from farmer 1. (Figure 36)

The rotor yarn structure has a much higher influence than the harvesting on tenacity and, as expected, the strength is much lower with the same yarn count than a ring yarn. As already seen in ring yarn, that yarn from farmer 2 has a significantly higher strength.

Due to the impact of the rotor yarn structure, farmer 2 has here 1 to 1.5 cN/tex more strength than the cotton from farmer 1. (Figure 37)

Influence of Harvest Method Spindle and Stripper, Tenacity
100 % CO, Com4®ring, 4.2 αe, 15 000 min^{-1}, 40 mm ring diameter

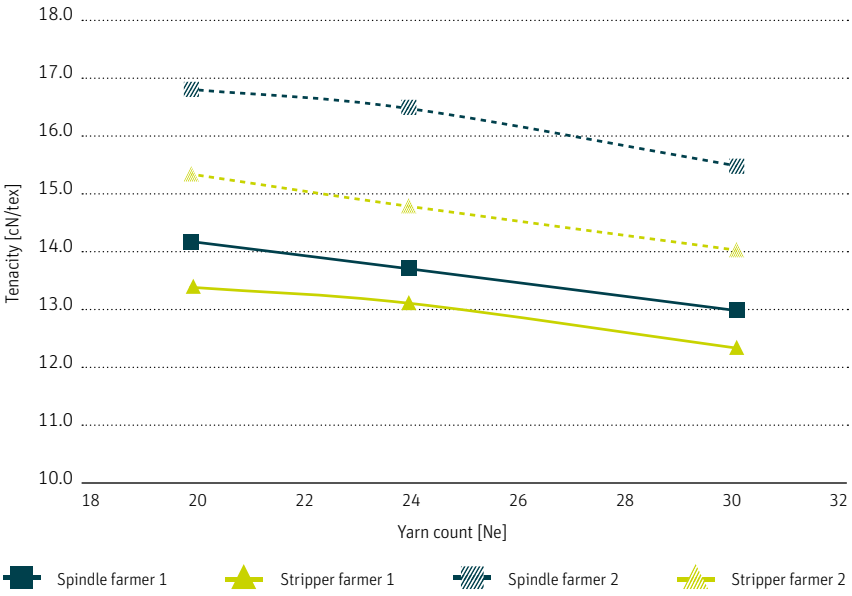


Fig. 36 Source: RAS-XT / RAS-XTP Technology TIS 26815

Influence of Harvest Method Spindle and Stripper, Tenacity
100 % CO, Com4®rotor, 4.2 αe, 28 mm rotor diameter

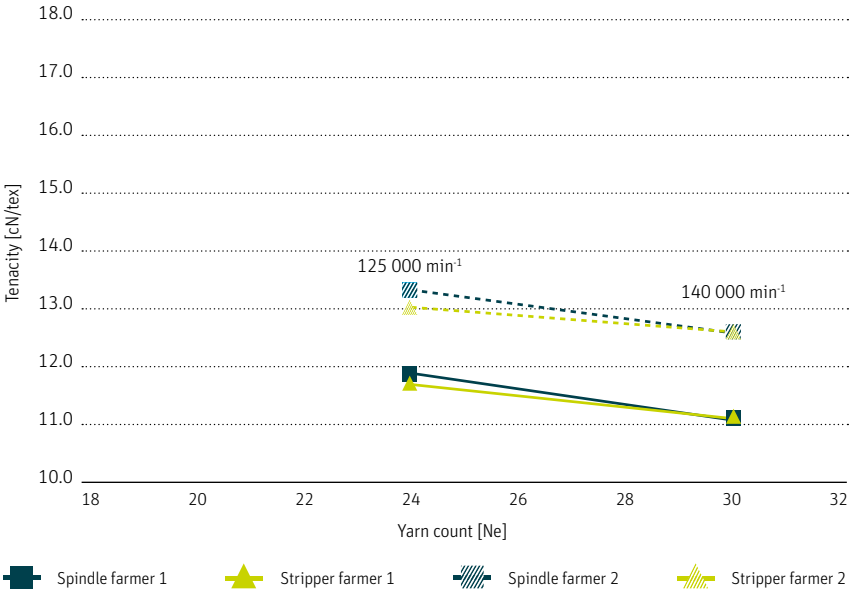


Fig. 37 Source: RAS-XT / RAS-XTP Technology TIS 26815

Higher yarn strength means lower elongation with similar type of raw material.

So spindle harvesting results in lower yarn elongation due to higher yarn strength.

Farmer 2 has a higher yarn elongation of absolute 0.5 – 1 % because of the slightly higher fibre elongation. (Figure 38)

The lower yarn elongation with spindle harvesting can be confirmed also on rotor yarn but the higher yarn strength could not be realised.

However, also the higher elongation with cotton from farmer 2 with absolute 0.5 % in comparison to farmer 1 can be confirmed. (Figure 39)

Influence of Harvest Method Spindle and Stripper, Elongation
100 % CO, Com4®ring, 4.2 αe, 15 000 min^{-1}, 40 mm ring diameter

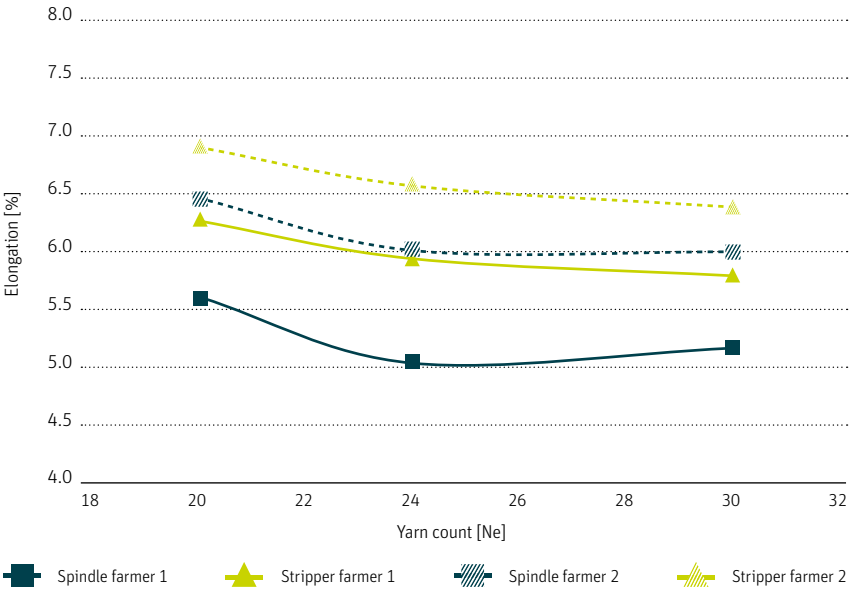


Fig. 38 Source: RAS-XT / RAS-XTP Technology TIS 26815

Influence of Harvest Method Spindle and Stripper, Elongation
100 % CO, Com4®rotor, 4.2 αe, 28 mm rotor diameter

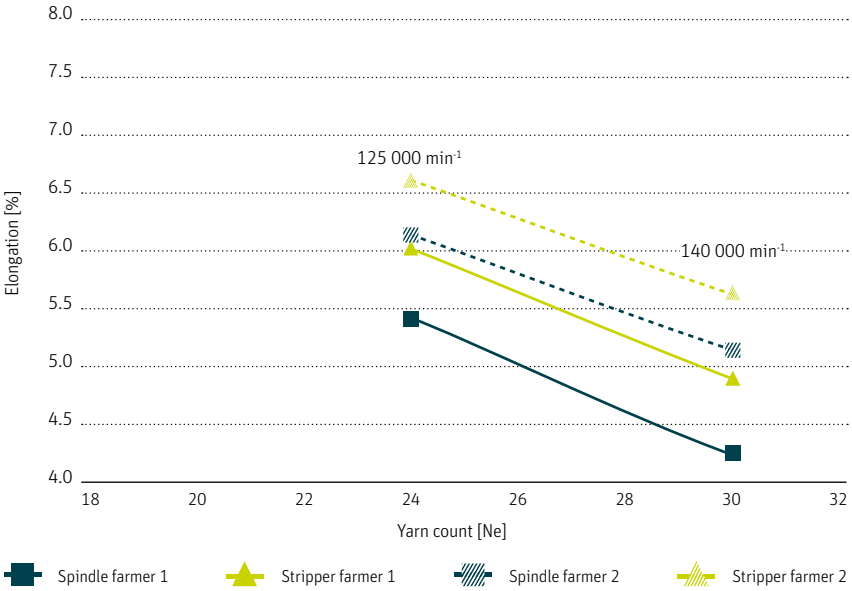


Fig. 39 Source: RAS-XT / RAS-XTP Technology TIS 26815

7.4. Yarn hairiness

Hairiness is directly linked to short fibre content. The higher the short fibre content in raw material, the higher will be the yarn hairiness.

The spindle harvesting shows a lower hairiness than with the stripper.

Between the cotton of farmer 1 and framer 2 there is no difference. (Figure 40)

The influence of hairiness is much higher with the yarn structure of rotor yarn than the influence of the harvesting method and the difference in the short fibre content from each farmer. (Figure 41)

7.5. Yarn structure

The visual yarn structure reflects generally a lot of the measured values and can be helpful for the value interpretation. So the optical effect helps to understand the influence of the spinning technology on the yarn. In that case, we can say that the influence of harvesting as well the farmer cannot be seen in the yarn structure. (Figure 42 + 43)

The difference between ring and rotor yarn, working in such a high amount of short fibres, can clearly demonstrated. The much better evenness and lower hairiness is impressive using the rotor technology. (Figure 44)

Influence of Harvest Method Spindle and Stripper, Hairiness
100 % CO, Com4®ring, 4.2 αe, 15 000 min^{-1}, 40 mm ring diameter

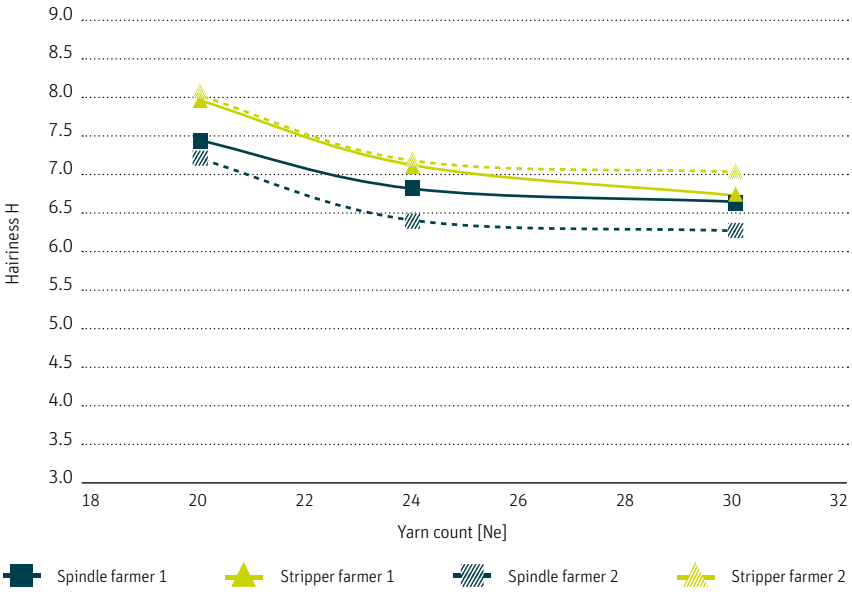


Fig. 40 Source: RAS-XT / RAS-XTP Technology TIS 26815

Influence of Harvest Method Spindle and Stripper, Hairiness
100 % CO, Com4®rotor, 4.2 αe, 28 mm rotor diameter

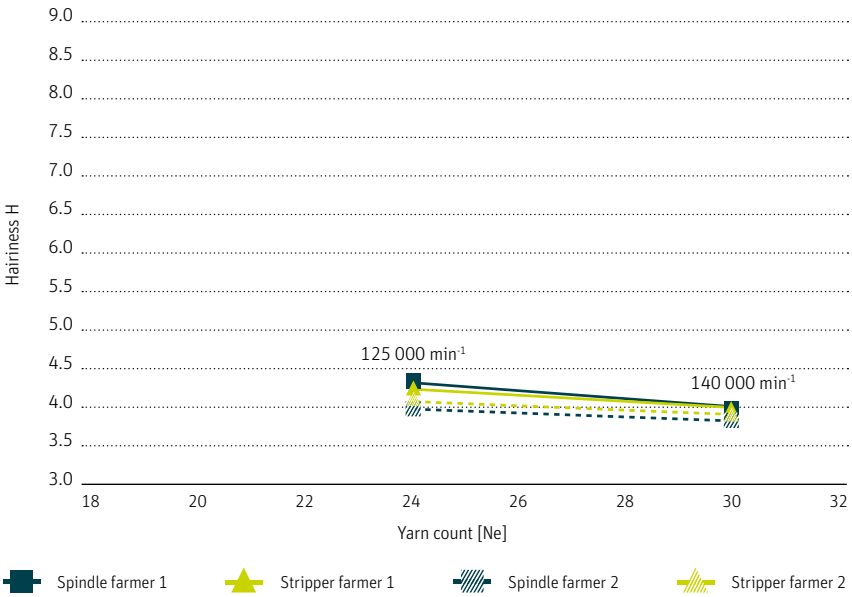


Fig. 41 Source: RAS-XT / RAS-XTP Technology TIS 26815

Yarn Structure

100 % CO, Com4®ring, Ne 24, 4.2 αe, 15 000 min^{-1}, 40 mm ring diameter

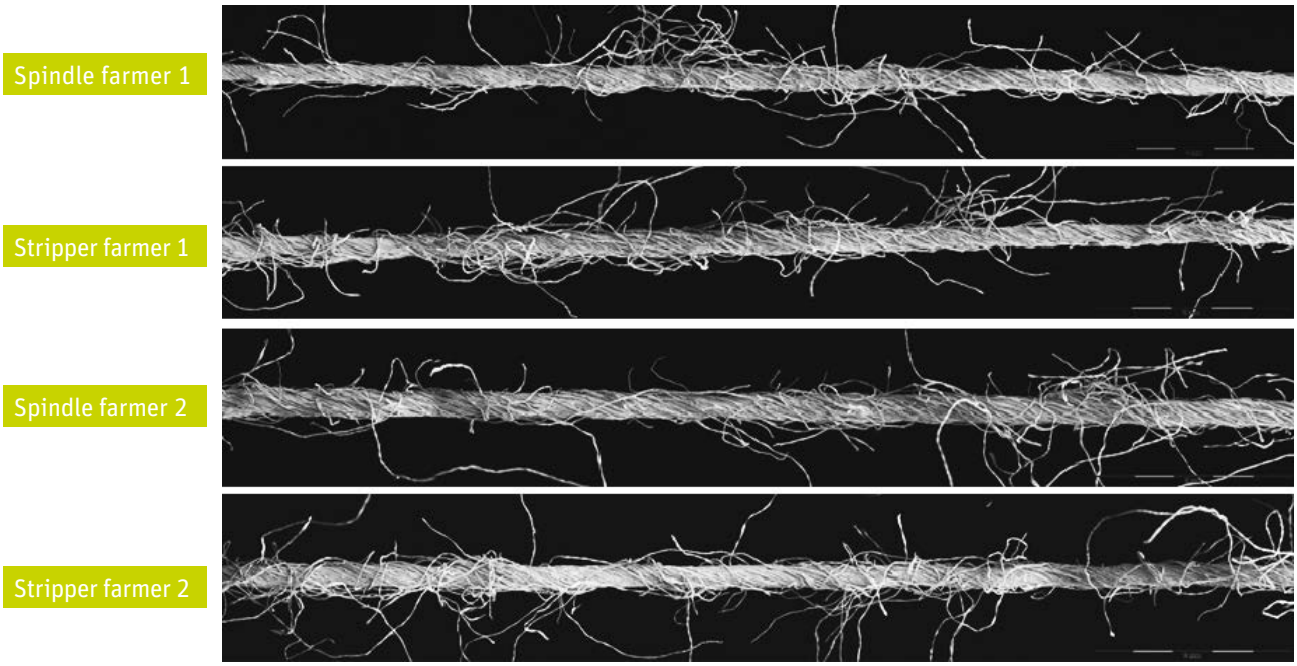


Fig. 42

Source: RAS-XT / RAS-XTP Technology TIS 26815

Yarn Structure

100 % CO, Com4®rotor, Ne 24, 4.2 αe, 125 000 min^{-1}, 28 mm rotor diameter

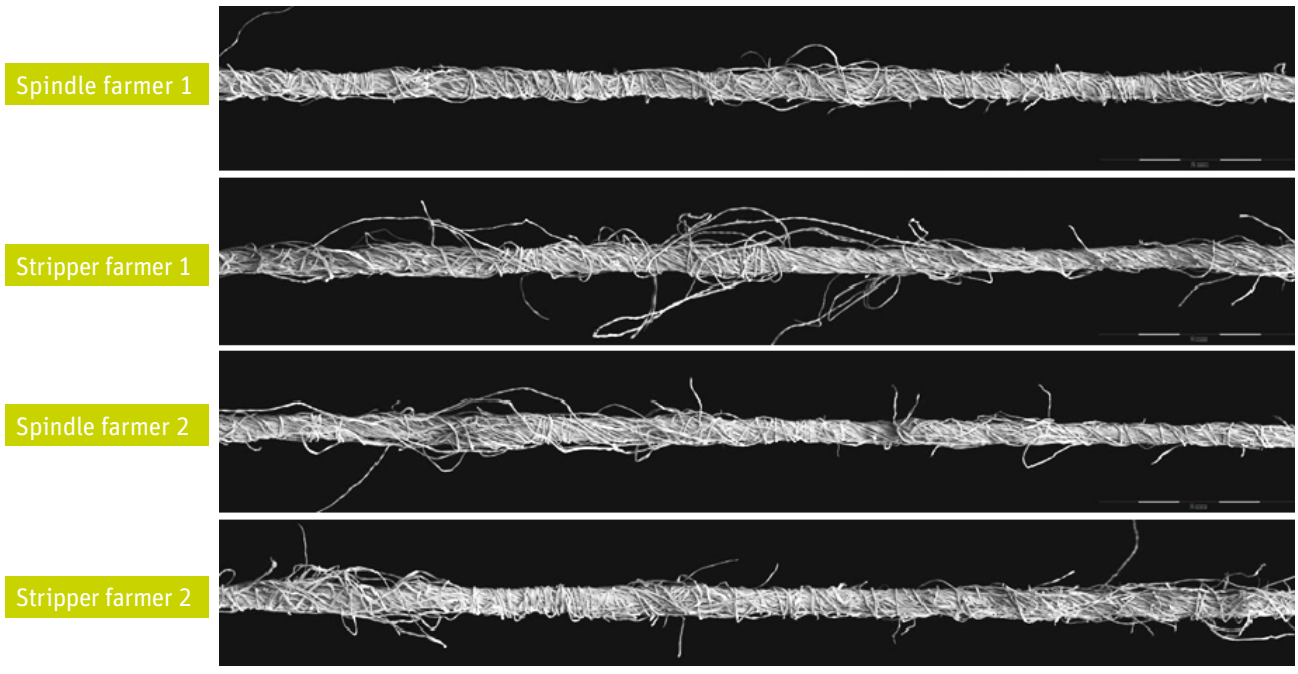
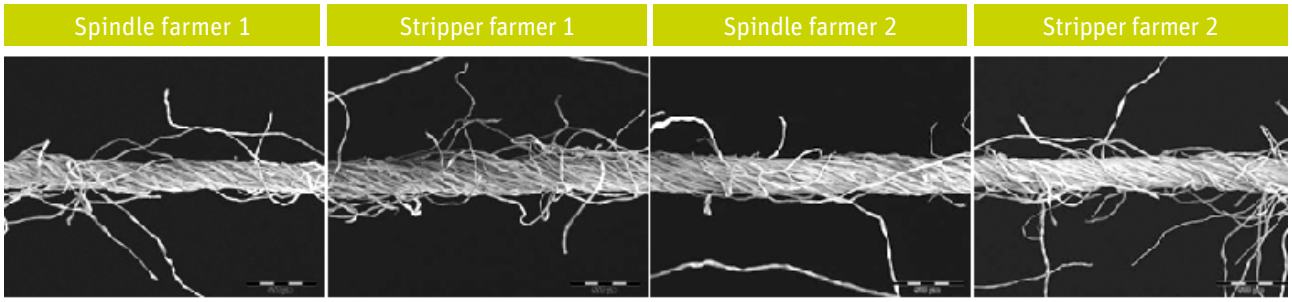


Fig. 43

Source: RAS-XT / RAS-XTP Technology TIS 26815

Yarn Structure

100 % CO, Com4®ring, Ne 24, 4.2 αe, 15 000 min^{-1}, 40 mm ring diameter



Yarn Structure

100 % CO, Com4®rotor, Ne 24, 4.2 αe, 125 000 min^{-1}, 28 mm rotor diameter

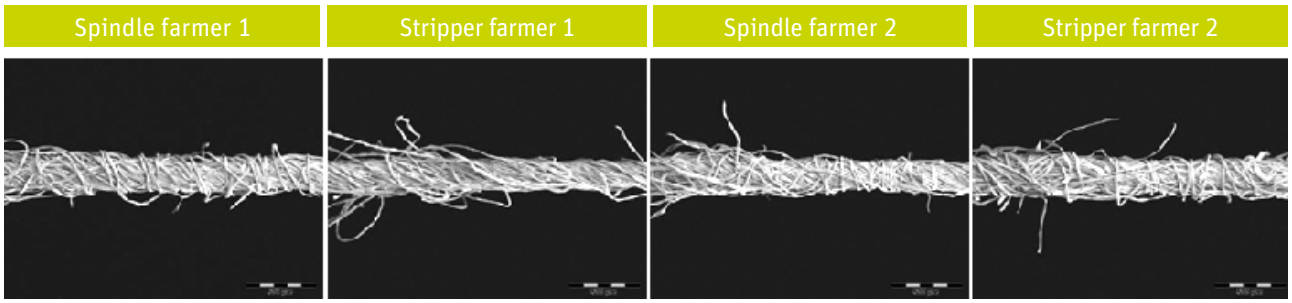


Fig. 44 Source: RAS-XT / RAS-XTP Technology TIS 26815

Overview Cotton Analysis, Ring Yarn

	Spindle in comparison to stripper	Farmer 1 in comparison to farmer 2
Evenness	better or same	worse
Neps	better or same	more
Strength	higher	less
Elongation	less	less
Hairiness	lower	same

Fig. 45 Source: RAS-XT / RAS-XTP Technology TIS 26815

Overview Cotton Analysis, Rotor Yarn

	Spindle in comparison to stripper	Farmer 1 in comparison to farmer 2
Evenness	same	worse
Neps	more	more
Strength	same	less
Elongation	less	less
Hairiness	same	same

Fig. 46 Source: RAS-XT / RAS-XTP Technology TIS 26815

8. Results of Fabric

The knitted fabrics from ring yarn are relatively uneven due to the high short fibre content. This makes a differentiation between the test positions rather more difficult. Nevertheless, on more critical examination, the yarn evenness determined can again be recognised, also in the knitted fabric. Mainly with farmer 2, in favour of the spindle harvesting method.

With farmer 1, the differences in the "fabric" also result slightly in favour of the spindle harvesting method. This, however, is in contradiction to the yarn unevenness which in the technical measurement is slightly in favour of the stripper method. (Figure 47+48)

Knit Structure

100 % CO, Com4®ring, Ne 24, 4.2 αe, 15 000 min^{-1}, 40 mm ring diameter

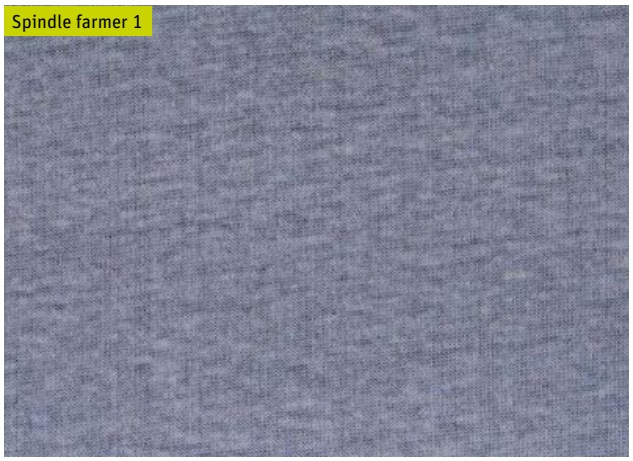


Fig. 47

Source: RAS-XT / RAS-XTP Technology TIS 26815

Knit Structure

100 % CO, Com4®ring, Ne 24, 4.2 αe, 15 000 min^{-1}, 40 mm ring diameter

Fig. 48

Source: RAS-XT / RAS-XTP Technology TIS 26815

A massive difference can be identified with knits produced from rotor yarn in comparison to those from ring yarn. The knits from rotor yarn, as was also determined with the yarn unevenness, show a far better evenness than with ring yarn.

That means, the influence of the end spinning technology on the evenness of the knitted fabric is far higher than the influence of the harvesting method. Furthermore, with farmer 1 the knit evenness is in favour of the spindle method. With the cotton utilised from farmer 2, no differences between the harvesting methods can be recognised. (Figure 49+50)

Knit Structure

100 % CO, Com4®rotor, Ne 24, 4.2 αe, 125 000 min^{-1}, 28 mm rotor diameter

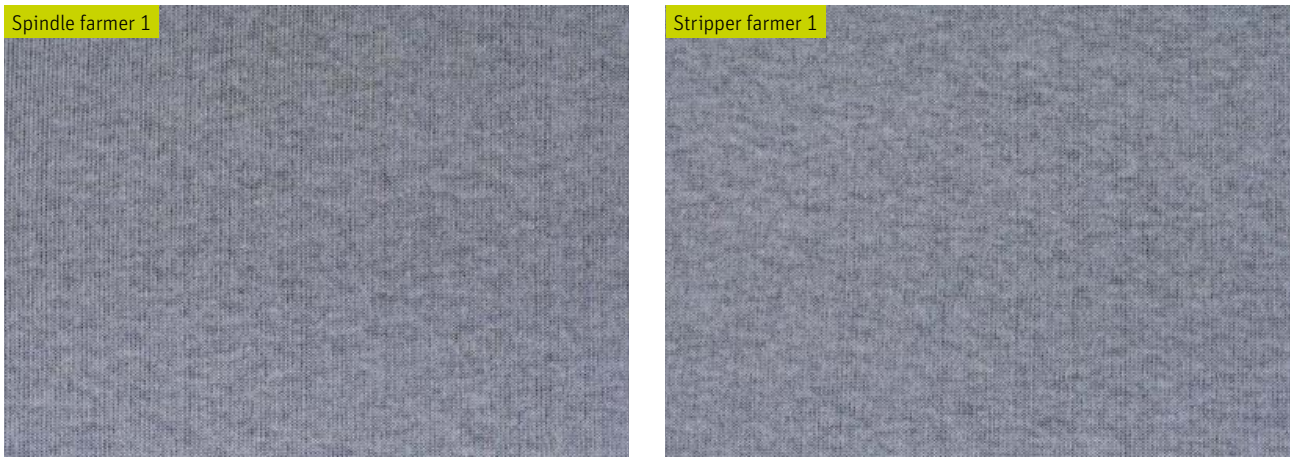


Fig. 49

Source: RAS-XT / RAS-XTP Technology TIS 26815

Knit Structure

100 % CO, Com4®rotor, Ne 24, 4.2 αe, 125 000 min^{-1}, 28 mm rotor diameter

Fig. 50

Source: RAS-XT / RAS-XTP Technology TIS 26815

9. Economics

Using the example of a yarn count of Ne 24 – 30 produced in South Africa, the rotor yarn shows a more economical production by approx. 40 – 46 % in comparison to a ring yarn.

Utilisation of ring yarns shows great differences in the yarn manufacturing costs which are country-specific. However, rotor yarn shows a far smaller influence on the manufacturing costs in the respective location.

The main reason for the higher manufacturing costs in South Africa are the capital costs which, due to the interest rates and building costs, are far higher in comparison to Turkey and China. This means that when using rotor technology in South Africa, certain negative framework conditions which originate from the capital costs, can thus be compensated. (Figure 51)

Manufacturing Cost Comparison
100 % Cotton carded

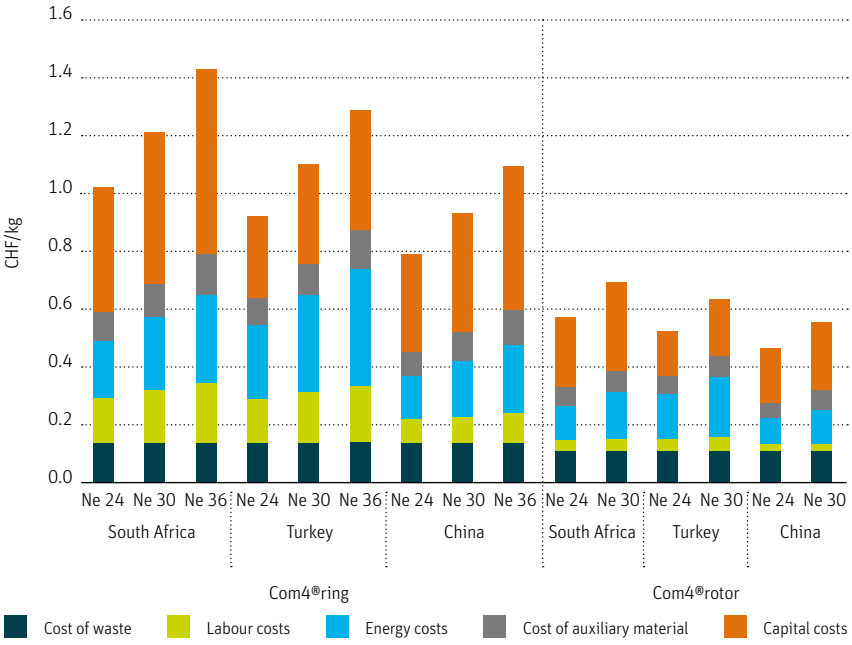


Fig. 51

10 Summary

From both locations, the lint obtained from the stripper cotton compared to the spindle picked cotton was considerably lower. The gin turnout results based on the stripper and spindle picked seed cotton on average amounted to 31 % compared to the 35 % lint turnout of the spindle picked cotton.

A higher middle staple length and lower short fibre content using the spindle harvesting have a positive effect on the ring yarn evenness. With the cotton especially from farmer 2, it can be confirmed that with the spindle method we reached a better evenness than with the stripper method.

As far as rotor yarn is concerned, there is no clear indication of the influence of spindle and stripper harvesting.

Spindle harvesting, independent of the cotton farmer, results in higher ring yarn strength.

So the yarn strength with spindle harvesting ranges from 0.5 cN/tex to 1.5 cN/tex higher than with stripper harvesting.

The unevenness in the fabric with both end spinning technologies slightly favours the spindle harvesting method.

The influence on the knitted fabric evenness from the end spinning technology is by far higher than the influence of the harvesting method.

It can therefore be recorded, that the knits, produced from rotor yarn, were more even than those from ring yarn. The reason is found in the short fibre content of the utilised cotton, which in the feed sliver of the respective end spinning process and depending on farmer and harvesting method, lies between 29 – 36 %.

That means, the fibre homogenisation with end spinning is more advantageous when applying the rotor yarn technology with the raw materials used. The finding corresponds with the previous technological experience, whereby a better unevenness is achieved by means of the rotor system, as soon as the short fibre content lies at > 30 %.

Taking the example of a yarn count of Ne 24 – 30 produced in South Africa, the rotor yarn shows production costs approx. 40 – 46 % lower compared to a ring yarn.

11. Notes

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