FORMULATION OF COTTON MIX: DEVELOPMENT FROM INDECISIVE TO DECISION SUPPORT SYSTEMS

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ABSTRACT
Consistency and optimization of Quality and Economy of the product yarn are the basic aspects; spinner should always need to be conscious about it. Formulation of the mix is the outcome of these constraints. But the selection of right components and their proportion in mix to reach the above mentioned target demands lot of brainstorming exercise, statistics and the human skills involved in this course. Drastic changes took place in the conventional practices used for the formulation of the mix to that of present practices going on. The limitations of conventional methods have been identified. The present method with the adoption of ANN, HVI and EFS has overcome these limitations to a greater extent. This paper explores in brief limitations of conventional approach; present method used along with the expected future trends.

***Key words*:** ANN, Bale management, Formulation of mix, GA, High Volume Instruments, Multicriteria Analysis.

Introduction:

Today, in the times of globalization it is required to produce yarn and fabrics of required quality and economic prices. This is possible with complete integration of fibre quality in the process of yarn manufacturing. This is related to the process of cotton fiber selection and cotton fiber blending. In this paper, it is being tried to discuss the progress made in formulation of mix from traditional indecisive period which was rather subjective to the decisive period of using decision making tools like ANN, multicriteria analysis, genetic algorithms, EFS and use of HVI and AFIS for obtaining comprehensive profiles of the raw material.

The indecisive period

The quality of final yarn is largely influenced (80%) by the characteristics of raw cotton [6]. Prior to the development of fiber testing equipments three fibre parameters have been used to determine the quality value of cotton fibre. These are grade, fibre length and fibre fineness. The expertise and experience played a dominant role, making the formulation of mix, highly subjective. One of the common approaches was massive blending, in which vast qualities of bales were mixed by grade or growth area to reduce variability. [17] Traditionally, the rising cost of labour, storage, equipment, and raw material makes the old blending approach largely impractical. Traditional fibre testing was a tedious and slow process, requiring 4 to 6 hours for testing a sample for the various properties. Because of this, only a small proportion of the bales in the lot were
tested [27]. In early eighties the introduction of evaluation of fibre properties using testing equipments like Baer sorter, Micronaire, trash analyzer etc made the process less subjective. This evaluation included use of statistical methods to determine the overall fibre properties. At the same time methods were developed which helped in deciding mix parameter for achieving particular yarn quality certain among them were FQI, Linear Programming.

The mathematical linear programming was used for cotton cost optimization. Though this approach was fundamentally sound, it was not accessible easily because of slow fiber testing and lack of powerful computing system for solving
the prolonged statistics. [9, 10].Linear programming method earlier used the simplex method has been mathematically stabilized and permits sensitivity and parametric analyses. Today use of computer and software programs has made mathematical complexity an easy task. [11, 12, 13, 14].

Thus, for producing a yarn of required characteristics, blend construction is important. The knowledge of fiber properties and careful selection of fiber bales are considered to be very critical. For efficient use of cotton and formulation of mix spinners require high quality detailed testing results. [1-4] it also requires fast and accurate methods to accurately analyze these results by using statistical techniques. All these demands Development of improved testing techniques which can reduce man hours and increase test speed as well as its accuracy. Besides, the economic impact of blending results from its ability to reduce costs [5] and maintain its quality. Any approach to establish a balanced relationship between optimization of cost and desired quality should fundamentally sound and easily accessible by all. All these efforts lead toward economic mix formulation to produce long term consistent quality yarn.

The decisive period

The decisive period has to operate two ways. Firstly, to solve statistical data with help of computer programs and secondly, development of high quality testing instruments. By late eighties the instruments were capable of testing 100 samples/hr or more. The development of fibre testing instruments such as the High Volume Instrument (HVI) and the Advanced Fibre Information System (AFIS) has revolutionized the concept of fibre testing. Thus, testing of 100% bales puts fibre selection on a scientific basis, rather than a matter of chance. That demands evaluation of fibre characteristics right from the gin to the point where formulation of mix takes place. HVI Applications in this regard are well illustrated in the following flowchart.

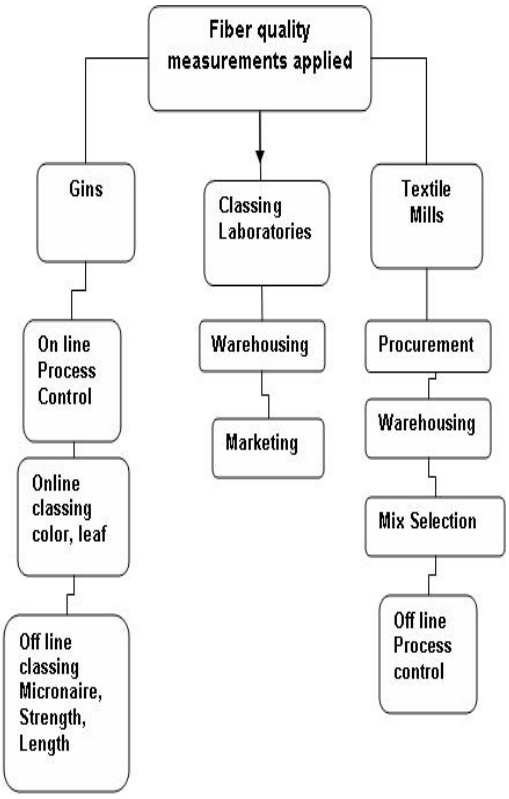

Figure 1 HVI applications [28]

The HVI produces comprehensive profiles of 180 bales per hour that contain specific measurement of all seven parameters listed by the USDA.With the HVI it is pragmatically possible to determine most of the quality characteristics of a cotton bale within two minutes.[16] Data generated by these instruments can easily be utilized with microcomputers and powerful software programs. [15]. Based on the HVI results, composite index such as Spinning consistency index (SCI) and (PDI) can be used to determine the technological and economical value of cotton.

SCI is a calculation for predicting the overall quality and spinnability of the cotton fibre. The use of SCI in selecting bales is to gain the advantage that all major cotton properties have been selected in a controlled way as SCI contain six controlled is achieved by this regression equation used is :

SCI=-414.67+209*strength-9.32*Micronaire+ 49.17*UHML+4.74*UI+065*Rd+0.36*(+b)
Where:
UHML is upper half mean length in inches,
UI is uniformity index,
Rd is the reflectance degree, and
(+b) is the yellowness of cotton fibre.

PDI was proposed by Mogazhy et al. [29]. It includes the development of a multiple regression equation relating fibre properties and yarn strength, the determination of the percentage contribution of fibre properties to yarn strength, the selection of a reference set of cotton properties, the determination of a difference factor between the fibre property and the reference set, and finally the development of a premium-discount formula. The premium-discount index (PDI) could be calculated using the following equation based on the percentage contribution of fibre properties Ci and the difference factor Di :

$$PDI = \sum_{i=1}^{N} (C_i . D_i)$$

This can play a pivotal role in an engineered fibre selection programme [7-8]. It gave the spinning technicians a single quality parameter incorporating the various fibre properties and a prediction expression to estimate the yarn properties from the fibre properties. [26] This paved the rapid development of a milestone in late eighties i.e. the concept of bale management and the new concept of yarn engineering.

Bale Management is based on categorizing the cotton bales according to fibre Quality characterstics.it mainly involves three steps. Firstly, Measurement of fibre properties of each bale by using only one instrument. Secondly, Separation of bales into class by giving 8 digit code and identifying method of storage as per the preferred input feed to minimize efforts of labour (reduced man power). Last, making a balanced mix of desired quality without undergoing faulty or excess procurement. Thus, Yarn Engineering is nothing but identification of bale procurement in terms of quality and quantity, storage pattern in warehouses and pattern of feed to first machine in the line. Also, the prediction of yarn parameters from fibre properties and Quick fibre analysis with the electronic data transfer tool. [18]. The same is shown in the form of compressed flowchart in figure 2

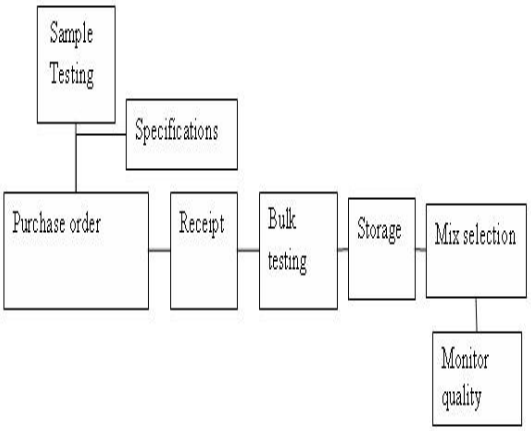

Figure 2: A typical bale management sequence.

Thus, the Engineered Fiber Selection (EFS) developed by Cotton Incorporated represents the program in the area of fiber selection and bale management in1980. This system can assist cotton users in many critical aspects including Bale management from the field to the textile mill, Production logistics, and Mix consistency [19]. A new software program was in 2003.This new program aims at providing systematic ways toward evaluating the performance of the cotton mix during manufacturing and determining the goodness of blending with respect to desired yarn quality levels. This program guides the user through different stages of manufacturing in such a way that allows profiling and monitoring the performance of the cotton bale laydown from raw fibers to the final yarn passing through all intermediated fiber strands such as carded sliver, drawn slivers, combed slivers and roving. Cotton incorporated has established this software in 1980 the schematic presentation of the same is shown in figure 3

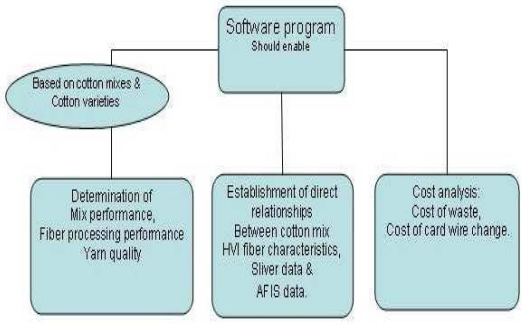

Fig – 3: Objectives of software program to optimize the utilization of cotton.

Next step of the same program is to produce a cotton fibre mixing model. [Figure - 4] It gives the impact of software programme solution on the cotton fibre mixing quality and cost. This can avoid the procurement of excess and unwanted varieties for a particular product yarn under consideration. As, this clarifies exact proportion of constituents in the mix and accordingly number of bales required at feed section. This can also execute the optimized mix cost simultaneously. Thus quality and cost; the two basic aspects of mix can be realized well in advance before bringing the cotton to the shop floor. [17]

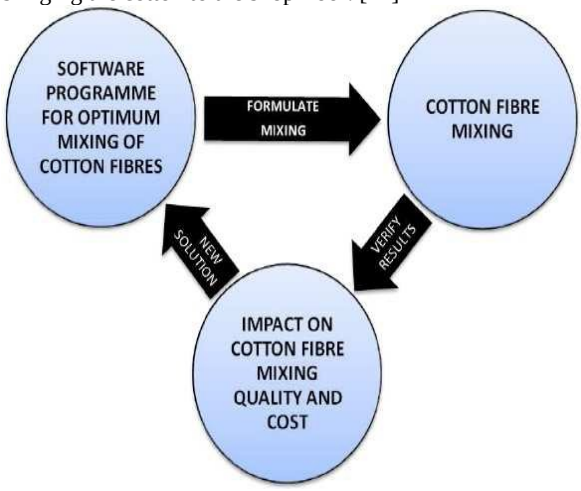

Fig -4: Cotton fibre mixing model [17]

Thus, the power of information lies in minimizing the massive data generated by the textile mill on daily basis, and maximizing the utilization of useful information derived from the data. Only a powerful software program can achieve such important goal. Using the above model the today's software can be used in order to find out what fibre parameters will be required for producing a particular type of fabric as shown in fig -5.

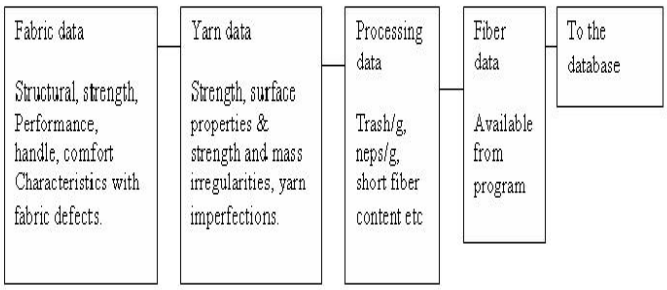

Figure 5: The schematic representation of procedure to find fiber parameter from fabric parameter.

It should also in collaboration with the application of artificial neural network; multi criteria system and genetic algorithms for cotton bale blending. Advent of high-speed fibre-testing machines and development of powerful modeling tools such as artificial neural network (ANN) have provided a great impetus in the

yarn engineering research. These tools provide the feasibility of yarn engineering by developing a yarn-to-fibre 'reverse' model. This approach is entirely different from the prevailing forward models, which predict the properties of final yarn by using the fibre properties, process parameters, machine parameters as inputs. Yarn properties are used to predict the fibre properties required.

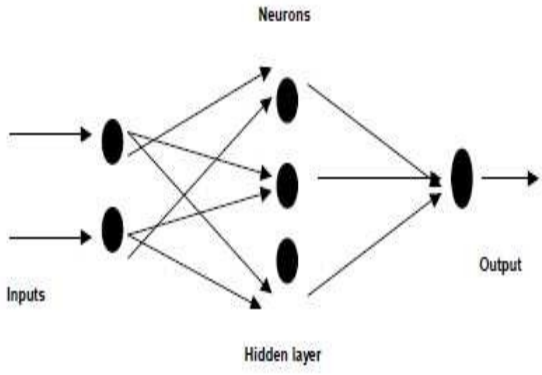

Figure 6: An Example of Single Output Neural Network. [25]

The cost minimization of cotton fibre mix was ensured by using the classical linear programming approach in combination with ANN. The engineered yarns produced by this method demonstrate good agreement with the yarn properties. Also it has been tried to formulate a bale selection procedure with the aid of an artificial neural network (ANN) model of back propagation considering only two cotton fibre attributes i.e. SCI and Micronaire

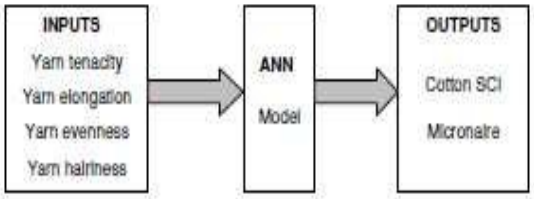

Figure 1 Structure of artificial neural network (ANN) model for yarn engineering. SCI = spinning consistency index.

Figure 7: Structure of artificial neural network (ANN) model for yarn engineering. [25]

The example of single output neural network is shown in figure 6 and Schematic representation of ANN model used for prediction is given. Six major yarn properties i.e. CSP, Tenacity, Elongation, Unevenness, Hairiness & yarn count were used as selected inputs for ANN models. The outputs were SCI and Micronaire.It was observed that correlation coefficients (R) between actual and predicted values are 0.800 and 0.0853 for SCI and Micronaire respectively. The mean error of individual yarn properties ranges from 3.82%-7.52%. The accuracy is very good in the cases of CSP, tenacity and hairiness. Incorporating the fibre elongation in the SCI equation could probably enhance the accuracy of bale selection.

Other Developments:

In the multicriteria decision making tools an easily approachable software STAT-ADM (statistical analysis with multicriteria decision) is used to choose the most adequate mixture formula for appropriate characteristics. [21-22] this software provides flexible techniques for cotton fiber selections by comparing and ranking the raw material. Here, hierarchies of cotton batches are obtained according to their contribution on the quality of yarns produced with a specific spinning system. [23]

The MCDM (multiplicative AHP) method based on a multiple-criteria decisionmaking technique is used to enhance the correlation between the technological value of cotton and yarn strength by performing rank correlation analysis between different methods. [24]

There is a mathematical technique called as Optimum Qualitative and quantitative Ration of Blending (OQQRB).It is designed to provide assistance throughout the bales management process. The mathematical formulation takes Into account all the four major properties of cotton. It provides the baseline for optimized ration of cotton bales for blending within few seconds. With the help of GA, cost of product can be reduced to greater extent. The quality of cotton bales mixing can be improved in the range of 7% to 15%. This tool can save up to Rs. 10,000 to Rs. 15,000 per day for a company. [20] This will increase the profit of the company. It will also help to optimize the use of available cotton varieties as shown in fig-8 and fig-9

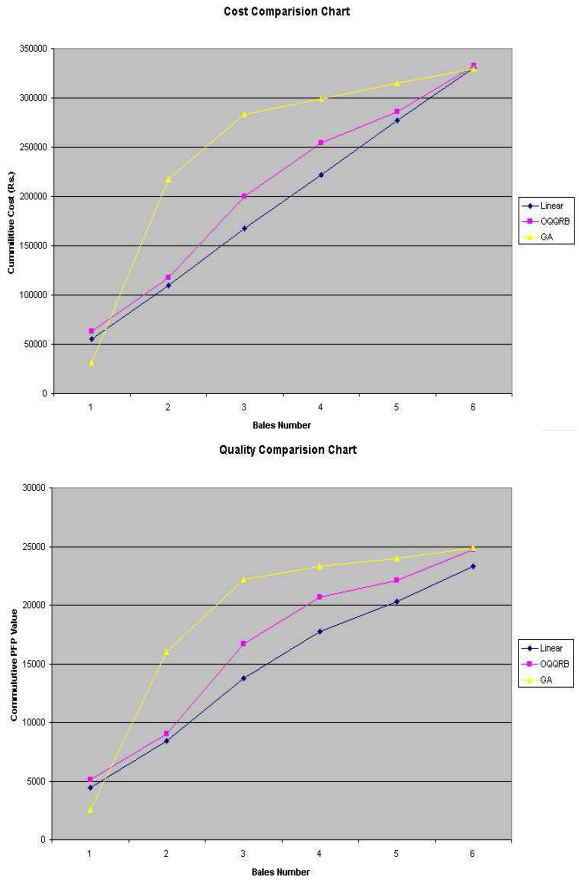

Figure 8, 9

Conclusion:

Effectiveness of formulation of mix sounds from the quality and economy of the product yarn. If there is any technique which can minimize the manual efforts in procuring optimized mix at an economical rate that will be the great achievement for textile sector. Conventional approach due to its slow speed testing, higher man component, laborious statistical evaluation fails in achieving this target. Advent of HVI, high tech testing in collaboration with ANN and computer programming for evaluation of large span data in fraction of second with higher accuracy has allowed the development of EFS and PDI. Both of this together led textile sector for optimization in the formulation of mix in 2000 AD. Still, efforts are going on which reflected in the use of multicriteria decision making tools.

Reference:

1) Bona.M, (1994),testing quality,physical methods of product and process control,textilia-Eurotex,pp.182-399
2) El Mogazhy, (1995), Manufacture of Staple Yarns,Handbook of Industrial Textiles,pp69-83
3) Balasubramanian. N, 1995, Fibre properties by HVI and conventional testing at different stages of spinning, IJFTR, 20, 63-72.
4) Fryer,L.F, (1996)Effects of cotton fiber blending and prpcessing on HVI Measurements –part-1,TRJ.66(6),349-357
5) Dame.S, 1965,The American Cotton handbook,vol 1.132-206,
6) USTER News bulletin, (1991),Measurement of the quality characteristics of
cotton fibre, 38, 23-31.
7) El Mogazhy, Y. E., and Gowayed, Y., (1995), Theory and practice of cotton
fibre selection, Part I: Fibre selection techniques and bale picking algorithms,
Text. Res. J., 65 (1), 32-40.
8) El Mogazhy, Y. E., and Gowayed, Y., (1995) Theory and practice of cotton
fibre selection, Part II: Sources of cotton mix variability and critical factors
affecting it, Text. Res. J., 65 (2), 75-84.
9)Bezdudnyi.F, (1965) Planning the most economic blend in cotton spinning,Technol.Textile Ind,5,3-7
10) Ram et al, (1864) Take the guess work out of blending. Textile Ind.128 (2),
75-77
11) Bland.R, (1977) New finite pivoting rules for the simplex method, math.
Oper.Res, 2,103-107
12) Murtagh, B.A, 1981”Advanced linear programming, McGraw-Hill Inc,.
13)ozan,T.M, 1986 Applied linear programming for production and Engineering
Management,NJ.
14) SAS/OR user’s guide version 6, 1989, SAS Institute Inc.Cary 227-316.
15) Technological value of cotton
16) S. Bhattacharya et al, June 1995, Testing and bale management,the Indian
textile journal , pp114-117.
17) Practices of cotton fibre selection and procurement for optimum mixing.
18) www.scribd.com
19) El Mogahzy, Yehia, 1998 “How the EFS® System Can Help in Producing
Optimum Yarn Quality”, 11th EFS® Conference,
20) Prof. Riyaz A. Sheikh and Dr. Ujwal A. Lanjewar , October 2010
”Decision support system for cotton bales blending using genetic algorithm”,
International Journal of Computer Applications, Volume 8– No.1
21)Andrasiu,M. and et al ,(1986)”Multicriteria based decision methods,”
Technical publishing house of Bucharest,Romania
22)Harpa R.,(1999)Contributions to the Optimization of the processing
parameters of unconventional cotton mixtures in carded
mill,Ph.D.Thesis,Iassy,Romania
23) Rodica Harpa,”Applications of Multicriteria Analysis in Cotton mill”, Textile

Research Journal, Vol 78(5)421-426.
24) Abhijit Majumdar, Prabal Kumar Majumdar & Bijan Sarkar," A Comparative Study of the Traditional and Multiple-Criteria Decision-Making Approaches".
25) A. Majumdar; P. K. Majumdar; B. Sarkar," Selecting cotton bales by spinning consistency index and Micronaire using artificial neural networks",
26) High Volume fibre testing, "Application Handbook".
27) B.A.Viswanath,"BLOWROOM – A Quality Centre in Spinning",
28) V.K.Kothari, Textile Progress Vol 1
29) EL Mogazhy, Y. E., (1990). Broughton, R., and Lynch, W. K., "A statistical approach for determining the technological value of cotton using HVI fibre properties", Text. Res. J., 60 (9), 495-500