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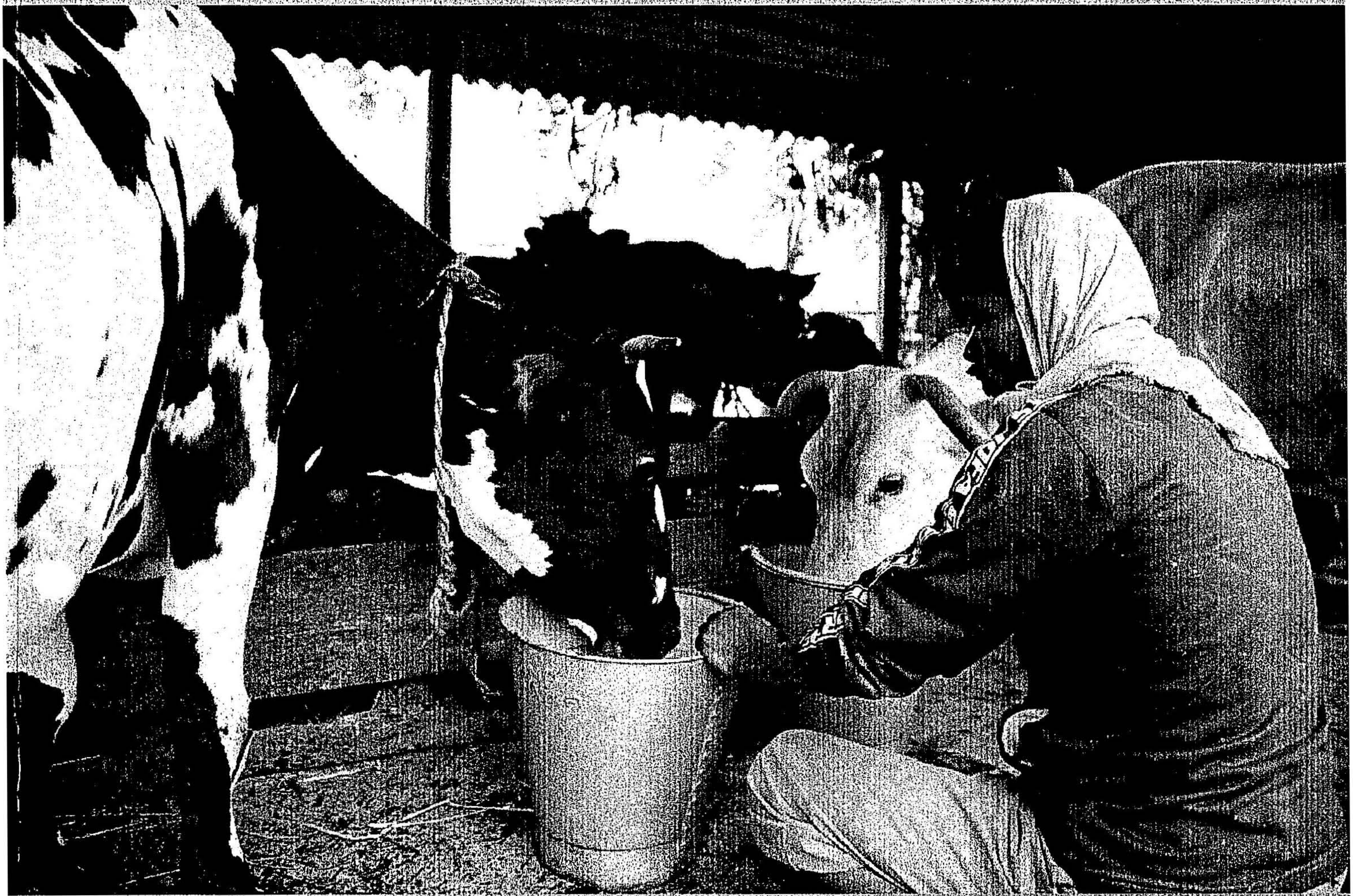

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Food-feed Crop Research and Multidimensional Crop Improvement in India

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INTRODUCTION

India has systematically quantified feed resources showing that crop residues (CR) were the most important single fodder source providing about 44% of the overall feed resources (NIANP, 2003). More recently, Ramachandra *et al.* (2007) predicted the contribution of CR to the Indian feed budget to reach almost 70% by the year 2020. Technologies for improving the nutritive quality of CR by physical, chemical or biological treatment have not been widely adopted, giving way to the new research paradigm of targeted improvement of CR fodder value by plant breeding and selection (Kristjianson and Zerbini, 1999). Increasing the feeding value of CR by genetic enhancement depends upon: a) nutritionally significant cultivar-dependent variation in CR fodder quality and b) sufficient independence between CR fodder traits and primary traits such as grain and pod yield. The present work reports findings on exploitable variations in food-feed traits of key crops and relationships between CR traits and grain and pod yield. The paper will also comment on the possible impact of improved CR on livestock productivity and other benefits from improved CR.

MATERIALS AND METHODS

Crop residue fodder quality traits were estimated using a combination of conventional laboratory analysis and Near Infrared Reflectance Spectroscopy (NIRS). Analyzed were a wide range of morphological, chemical and *in vitro* traits, but for brevity we mainly report on variations in *in vitro* digestibility which we found to be a valuable laboratory quality trait that was highly correlated with *in vivo* measurements and pricing in stover trading.

RESULTS

A monthly (November 2004 to November 2005) survey of six major Hyderabadi sorghum stover traders showed the cheapest stover type to be priced on average at 3.06 Rs. per kg dry stover and the most expensive type at 3.89 Rs. Difference in sorghum stover prices were well explained by differences in stover *in vitro* digestibility ranging on average from 47 to 52% and which accounted for 75% of the variations in stover prices (Blümmel and Rao, 2006). Stover quality differences of this order kind were observed in a wide range of new cultivars submitted to the National Research Center for Sorghum (NRCS) for release testing (Figure 1a). In main (*Kharif*) season cultivars, no negative relationship between stover *in vitro* digestibility and grain yield was observed and some of the cultivars with highest grain yields had also superior stover quality. Potential trade-offs between stover quality and grain yield were observed for off-season (*Rabi*) sorghum where stover digestibility accounted for 30% of the variations in grain yield (Figure 1a). However, stover digestibility among the highest grain yielding cultivars still varied by 5% units and more and cultivars with superior stover quality and grain relative to grain and pod aspects - more important. When Blümmel and Rao (2006) surveyed the sorghum stover market in Hyderabad from 2004 to 2005, average prices per kg dry stover in November 2004 and 2005 were 2.95 and 3.37 Rs, respectively. In November and December 2008, when we started a new collection cycle, these prices had increased to 8.57 and 7.45 Rs, respectively. Further indications are increased transports distances of CR and new CR entering the market chain, for example maize stover and chick pea straw which are now sold in fodder markets in Hyderabad. Crop residues are therefore, a strategic feed resource of high importance and there exists a need for inclusion and considerations of CR fodder traits in crop improvement. Crop improvement in India, particularly when working with dry-land crops, such as the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the National Research Center for Sorghum, has responded to this need in a very proactive way through collaborative research programs with the International Livestock Research Institute.

There are several levels of intensity of crop-livestock collaborative work on food-feed crops. For example, screening of released and commonly grown cultivars (which are often astonishingly small in number) does not need any specialized laboratory equipment for phenotyping of CR fodder quality. Most livestock nutritional laboratories will be equipped for such a task. Also, conventional crop improvement may not even consider CR yield, a measurement which could be easily included as selection criteria and which might be the first step in the development of food-feed type cultivars. Phenotyping for relationships of the kind described in Figure 1a-c requires specialized laboratory infrastructure to analyze large number of samples quickly and cheaply for fodder quality traits, and the technique of choice for this is NIRS. The ILRI-ICRISAT collaboration has established a NIRS hub at the ICRISAT campus at Patancheru that supports food-feed type research in sorghum, pearl millet, groundnut, pigeon pea, rice and maize. For example the NRCS sends laboratory technician to this hub for about 6 months per year to phenotype for sorghum stover quality traits in all cultivars submitted for release testing with the objective of developing weighing criteria for stover traits in new cultivars release decisions. However, the capacity of this hub is stretched to it is limit and we suggest to establish at least one more NIRS hub at an Indian partner institution. Discussions with the Indian Council for Agricultural Research are under way.

CONCLUSION

Crop residue based feeding systems can be improved by multidimensional crop improvement that includes CR fodder traits as selections, breeding and new cultivars release criteria. There is high livestock nutritionally significant cultivars-dependent variation in CR fodder quality that can be exploited without detriment to the primary traits of grain and pod yields.

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