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Research Article

Socio-Economic Dimension for Agro-Tech Transfer: A Case Study of Post-Rainy Sorghum Cultivars Transfer to Farming Communities in Adilabad, India

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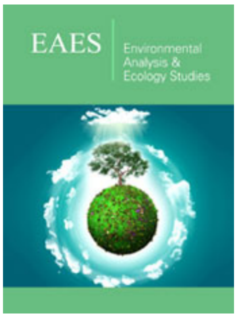
ISSN: 2578-0336



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Submission: November 01, 2019

Published: July 20, 2020

Volume 7 - Issue 1

How to cite this article: Krithika Anbazhagan, Marijn Voorhaar, Jana Kholová, Nedumaran Swamikannu, Aravazhi Selvaraj, et al. Socio-Economic Dimension for Agro-Tech Transfer: A Case Study of Post-Rainy Sorghum Cultivars Transfer to Farming Communities in Adilabad, India. Environ Anal Eco stud. 7(1). EAES.000655.2020.
DOI: 10.31031/EAES.2020.07.000655

Abstract

Adilabad district in Telangana, India, has a large proportion of tribal communities that are socially and economically insecure. Their livelihood depends predominantly on mixed crop-livestock systems, which consist of the cultivation of cotton and pigeonpea (legume) with high inputs during the rainy season, and sorghum (staple food cereal) with low inputs during the post-rainy season. Agro-climatic analysis shows that Adilabad is prone to very high climatic risk, thus threatening the livelihood security of tribal farming communities. Adoption of climate-smart, society-acceptable agro-technologies (e.g. suitable crops) is one of the options to mitigate the effects of current and future climatic conditions. Still, many current efforts aiming for agro-technologies transfer have not been impactful.

In this case study, we argue that for effective adoption of novel agro-technologies such as new post-rainy sorghum varieties, it is important to take into account not only the complexities of the production environment but also the socio-economic context, together with the first-hand involvement of the local communities. Results gathered during our farmer participatory sorghum cultivar selection highlights that the low yielding indigenous landrace is still preferred by farmers for its grain and stover qualities which over-weights the available high-yielding hybrid sorghum. Our study suggests that farmer-participatory technology selection and/or further development should be a baseline protocol to facilitate the introduction of relevant and sustainable interventions to the farming communities

Keywords: Semi-arid tropics; Low-input agri-system; Mixed crop-livestock systems; Post-rainy sorghum; Agro-technologies

Abbreviations: MCLS=Mixed Crop-Livestock System; SAT=Semi-Arid Tropics

Introduction

Agricultural intensification has historically focused on increasing agricultural productivity using improved crop varieties responsive to high inputs such as inorganic fertilizers, biocides and irrigation. This practice has helped many agri-systems to achieve self-sufficiency in food-grain produce. However, one of the shortcomings of this approach was that it favoured resource-rich farmers with access to irrigation and agricultural inputs (e.g. fertilizers, machinery) and often discriminated against resource-poor small-holder farmers in rainfed regions with large environmental risks [1]. These economically insecure farming communities whose diet largely depend on their own production often grow the landraces inherited from their ancestors. There could be several reasons for this phenomenon; for example, the novel cultivars may not be locally available or, if available, they might have been developed for a different and simpler context, thereby not meeting the farmers' needs.

An additional challenge is the access to good quality seed. These often reflects in farmers' willingness to take a risk of testing new crop cultivars with high impact on their livelihood in case of crop failure. This situation is further complicated in the communities that are economically insecure (<2$ per day; i.e. below the poverty threshold). Furthermore, the agro-tech transfer to smallholder and marginal farmers could be limited by their complex social structure, fragmentation of land holdings (2.28ha per household in 1971 to 1.16ha during 2011), decreasing water resources, and underdeveloped market infrastructure [2,3].

Yet, over the years, agricultural research has offered a wide range of crop varieties as options for the range of agronomic contexts in India. Therefore in our study, we tested whether any of the available cultivars might suit the needs of the farming communities in Adilabad (northern Telangana) which is one of the most challenging regions within the semi-arid agro-climatic zone of India [4]. The farming community is mainly composed of indigenous tribal populations (adivasis) who depend solely on farming for livelihood and income. About 93% of the farmers in Adilabad are smallholder farmers who own less than 4 ha of land. These communities are very distinct in their socio-cultural and politico-economic structure. With the region vulnerable to climatic extremes; access to crop options for improving their food and nutritional security as well as socio-economic status is complicated.

The National Family Health Survey of 2015 revealed that anaemia (65% of women and children) and malnutrition (35% of children underweight and stunted) is prevalent in this district. Over the years, with the availability of rice at affordable prices through the public distribution system, the cultivation system, dietary habits and fodder availability have gradually changed. There is a high likelihood that the community's health has been affected by these altered food habits. The recent study prioritized the climate-smart agricultural interventions, such as adoption of climate-resilient crop cultivars, which can considerably alleviate the situation in this region [4]. We argue that unless technology is relevant, sustainable and profitable in the socio-cultural and political context of the farming community it can hardly be adopted.

Therefore, the main objectives of this presented case were to

A. Analyse characters of post-rainy sorghum crop required by the very specific tribal farming communities in Adilabad

B. Strategically and effectively test a panel of existing elite cultivars for suitability the communities' needs,

C. Validate whether the farmer-participatory sorghum cultivar selection might be a viable option for accelerated crop-cultivar adoption, and

D. Draft a protocol to analyse the farmers' demand in support of effective selection/development of sorghum cultivars addressing complex stakeholders needs.

Case Presentation

Our targeted ex-ante survey consisted of 50 tribal farmer families in Utnoor mandal of Adilabad. We identified, that despite the small landholding and limited resources, the farmers were responsive to the local market fluctuations and change their cropping pattern according to the market situation. Their primary commercial crop is cotton and pigeonpea (legume) cultivated with high inputs during the rainy season followed by sorghum (cereal, staple food and fodder) planted in the post-rainy season with low inputs. Our survey further focused on the post-rainy sorghum cultivation system and the specific characteristics of sorghum crop preferred by the target tribal communities. Individual surveys as well as focused farmer group discussions revealed that till date farmers preferred their landraces (e.g. Sevatta jonna and Persa jonna inherited from their ancestors) over the locally available sorghum hybrid primarily for taste and fodder quality and quantity. The farmers' field surveys in Utnoor pointed to the susceptibility of landraces to diseases (e.g. charcoal rot). Based on these findings, we took the following steps-all including farmer participation:

Table 1: Details of two dual-purpose sorghum cultivars selected from 18 elite post-rainy sorghum cultivars in on-station trial at ICRISAT in comparison to "Keslapoor Sorghum" (Adilabad originated landrace).

Treatment	Cultivar	Yield		% Gain Over Landrace	
		Grain (kg/ha)	Stover (kg/ha)	Grain	Stover
High input system (irrigated, fertilized with 100kg DAP ha^{-1} and 100kg urea ha^{-1})	Keslapoor Sorghum	3719	5628	-	-
	Phule Chitra (SPV 1546)	4146	7361	11.5	30.8
	CSV 22	4087	7109	9.9	26.3
Low input system (1 irrigation at sowing, no fertilizer)	Keslapoor Sorghum	1434	4086	-	-
	Phule Chitra (SPV 1546)	1823	4651	27.1	13.8
	CSV 22	2085	4730	45.3	15.8

a. On-station selection of two elite cultivars was based on stover and grain yield (emphasizing production in low input), the findings of the survey and the cultivar characters identified with the participation of 15 farmers representing the region: The trial in 2017 compared the performance of 18 elite sorghum cultivars along with the landrace from Adilabad under high-input and low-input conditions. Two dual-purpose cultivars that performed well under low-input conditions compared to the landrace in terms of grain (25-45% higher) and stover weight (~15% higher) were selected (Table 1). Apart from tasting the raw grains for taste and hardness, and visually evaluating the fodder quantity, the farmers paid specific attention to the grain awns that, in their opinion, would reduce bird damage.

b. On-farm testing of the selected elite cultivars along with checks (M35-1 and Adilabad landrace): The crop was planted in fields of nine progressive farmers spread across eight villages of Utnoor mandal on 13-14 Oct 2018. The four cultivars of sorghum were sown in plot sizes of 40-60m2 (Figure 1) with planting density of ~20 plants m-2 and further cultivated by farmers according to their usual practice;

I. Keslapoor sorghum (traditionally cultivated Adilabad originated landrace)

II. M35-1 (Released cultivar suitable for post-rainy season, general check)

III. CSV 22 (Released cultivar suitable for postrainy cultivation in medium-deep soils; identified with high grain and fodder yield under low input conditions)

Figure 1: Sowing of sorghum cultivars with the farmers at Chintakara village with the layout of the field.

IV. Phule Chitra (Cultivar suitable for postrainy cultivation; identified with high grain and fodder yield under low input conditions)

c. Farmers' response and knowledge exchange: We intended the farmer trials to function as a demonstration plots for neighbouring farmers who, indeed, keenly participated in farmer group discussions and shared their opinions and preferences. During the monitoring visit, the farmers were trained to use the selfing-bags to multiply the pure seed of the preferred cultivars. The women who are the decision-makers for the food consumed in the families were asked to harvest the panicles of each cultivar separately for the further process (below).

d. Post-harvest farmers' feedback: Eight farmers participating in the study indicated preference to CSV22 for its fodder quality (palatability for animals) and quantity, and Phule Chitra for its grain quality. During the group discussion, farmers identified the prolific branching in the semi-compact panicles of Phule Chitra as a preferred trait (Figure 2). The women cooked sorghum of different cultivars separately (flat bread (roti) and porridge (kichidi-pongal)) to be tasted and roughly scored for organoleptic qualities as per the preferences of the community members (Figure 3). Although these were highly subjective observations, the consensus of 40 participating individuals from two villages suggested that the taste of the food prepared with Phule Chitra was comparable to that of their local landrace.

Figure 2: Farmers trained to use
(a) Selfing bags to multiply seeds.
(b) Separate harvesting the different cultivars and
(c) Documenting farmers' response.

Figure 3: Documenting the farmers' opinion after the on-farm variety testing at Chintakara village and basic scoring for cooked sorghum products qualities with the farming community.

Discussion and Conclusion

Globally, sorghum (Sorghum bicolor L.) is a resilient crop choice for many farming communities practicing low-input agricultural practices in harsh SAT environments. Sorghum might become an important agro-technology to maintain agri-system productivity and resilience in the foreseen climatic changes [5-7]. Our specific case study confirms that there is a high potential and scope for improving the mixed crop-livestock systems (MCLS) in high-climate risk zones of Telangana, India, through the introduction of climate-resilient sorghum [4]. In our team itself (http://www.gems.icrisat.org), a multiple sorghum technologies using high-end scientific methods are being developed to further alleviate the negative effect of unpredictable current and future climates on sorghum production [6,8].

For the Indian community of adivasis living in high-climate risk environments and characterized by complex socio-cultural and political distinctiveness which we selected in our case study, sorghum is the main staple food and therefore vital for their food security as it is the primary source of theif food and fodder [9]. However, with rice accessible through the public distribution system (i.e. Indian Government scheme) and poor sorghum seed distribution system (only low yielding landraces and hybrids available in the region that do not match this community requirements for taste/cooking quality/fodder quantity), the health of humans as well as animals has drastically reduced (productivity of cows ~1L from 4 cows per day in the region of study) (ICRISAT project reports 20192).

Yet, its well documented that one unit increase in sorghum stover digestibility would result in 6-8% increase in milk productivity [10,11-16] and these sorghum technologies are already available on shelf [12]. Therefore, technologies enhancing sorghum stover digestibility and palatability can increase the milk production but also the nutrition of women and children and, in turn, enhance household income through the sale of surplus milk if only these would effectively reach the end-users.

In summary, through our initial pilot study, we already found compelling evidence that focused and organized involvement of the target stakeholders provides valuable opportunities to comprehend from the indigenous knowledge and is critical for every step of agro-technology transfer or novel technology development. The accelerated dissemination of such interventions can be further strengthened through participation of local seed distribution systems, value chain market linkages and favourable government policies.

Acknowledgement

This work has been supported by the CGIAR-Research Programme for Grain Legumes and Dryland Cereals (CRP-GLDC). We are thankful to the Agribusiness and Innovations Platform (AIP, ICRISAT), who had established a successful network with the local Adilabad governing bodies and stakeholders through their "Nutri-Food Basket" project. The encouragement and support of the district collector of Adilabad, Divya Devarajan, and her team is gratefully acknowledged. We highly value our collaboration with the team of Center for Collective Development, Utnoor, Adilabad who facilitated the research work with the tribal farming communities. The GEMS team from ICRISAT, Dr. Thannamal Ravichandran from International Livestock Research Institute (ILRI); and graduate students from Centurion University (Odisha) are duly thanked for their contribution in conducting the ex-ante survey and field trials in villages of Utnoor mandal.

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