FINAL REPORT

राकृनप
NAIP

National Agricultural Innovation Project

(Indian Council of Agricultural Research)

Value Chain on Value Added Products Derived from *Prosopis juliflora*

2014

Central Arid Zone Research Institute

Jodhpur-342003

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Central Arid Zone Research Institute, Jodhpur-342 003

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Forward

As a major difference between plantation and agroforestry, and irrigated agriculture, off course, was that there were many more species of trees then of staple food crops. The great impact of green revaluation in human food security suggested that there must be potentially similar increase in yield available from the identification of tree species which are distributed abundantly but very little known about their importance in livestock and human diet. Introduction of exotic woody species have not only provide evidence of rapid growth and expansion but have also highlighted risk of them becoming obnoxious weed. *Prosopis juliflora* fits to this dilemma.

Scientist, policy planners, foresters, development agencies and many NGOs have been campaigning against the species since last three decades. Their major concern are the species' weedy thorny nature and weedy spread. They talk of eradication of the species. In fact, the earlier works of CAZRI, Jodhpur clearly demonstrated the best management option for *P. juliflora*, especially in Indians sub- continent is to exploit it for the production of animal feed, fuel wood and timber. The eradication of the species is not possible as all the earlier attempts in USA, Mexico and Australia failed and therefore, there was need to develop an integrated programme on its management and utilization.

The present NAIP sub-project "value chain on value added products derived from *Prosopis juliflora*" under production to consumption system (Component-II) provided an opportunity to work in the right direction i.e., management through exploitation. The consortium led by CAZRI worked hard in frontier of technology development for processing various kinds of food and feed items from *P. juliflora* pods and creating a value chain of developed products. The consortium leader Dr. M. M. Roy, Director, CAZRI, Jodhpur and CPI, Dr. J.C. Tewari, Principal Scientist (Forestry), CAZRI with entire team members of the sub-project done exhaustive work, which has been a landmark in *P. juliflora* R&D. The value chain developed in the sub-project has been appreciated in national and international forums. No report is the final word on any subject but this one should last a long time and provide vital source of information to scientist, farmers, foresters, academicians, and industrialists on use of *P. juliflora* pods for processing various products for human and livestock use. I congratulate entire team of this sub-project in general, and Dr. M. M. Roy and Dr. J. C. Tewari, particularly for their dedicated efforts.

(Dr. K. R. Solanki)
Chairma, CAC

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PREFACE

Prosopis juliflora, native to south and central America and the Caribbean, was introduced in India during 1870s on account of its evergreen nature, fast growth, fuel wood use, tolerance towards arid conditions and saline soils. However, because of plants' inbuilt mechanism to overcome adverse situations its spread and growth has been tremendous – invading many other areas like grasslands, protected areas etc., creating a negative pressure on biodiversity. This has created an impression amongst several groups that this species is a threat to the environment. The large scale eradication and further reforestation is a very costly option. The other viewpoint is to have a strategy to utilize this tree in a manner that enlarges livelihood options for the people besides the preventing steps for its spread in undesirable areas.

On these lines, the NAIP sub-project of component-II entitled **Value chain on value added products derived from *Prosopis juliflora*** was implemented at this institute for six years. It started from collection of baseline data with a view to develop a value chain for its products. In the process many technologies were developed and some of them have been commercialized, though on a local scale. All the partners of consortium including voluntary partners and team of Co-PIs of lead consortium partner CAZRI, Jodhpur contributed substantially to solve complex problems through better understanding of the subject. It identified possible pathways for creation of successful value chain of *P. juliflora* pod based products for human and livestock consumption.

This study suggested that best management practices for this species may be utilized by empowering people by organizing them through local cooperatives, accessing transport facilities for primary tree produce, supporting new enterprise by R&D, skill development for processing new products. A strong extension programmes on these lines will encourage rural folk to become involved in *P. juliflora* related business.

It is hoped that this report will be very beneficial to all who want to process *P. juliflora* pod for value added products and develop a production to consumption system value for the benefit of all stakeholders and in promotion of entrepreneurship(s).

(M. M. Roy)
Director and Project Leader

CONTENTS

सारांश

विलायती बबूल के महत्व को लेकर समाज के विभिन्न वर्गो में अनेक तर्क एवं वितर्क मध्य सामान्यतः यह माने जाने लगा है कि यह वृक्ष समाज के कमजोर तबके की अनेक आवश्यकताओं की पूर्ति करता हैं। इस बबूल की लोकप्रियता इससे होने वाली आय से सम्बन्धित है और इसके विपक्ष में तर्क देने वाले लोग प्रायः धनाढ्य कुल से है जिनका खाना रसोई गैस पर बनता है और जिनका पशुपालन से कोई सम्बन्ध नहीं है। ग्रामीण क्षेत्रों में यह वृक्ष पशुओं के लिए चारा तथा जलाने के लिए ईंधन उपलब्ध कराता है। कुलीन वर्ग की टिप्पणीयाँ जो इस वृक्ष को लेकर है कि यह भूमि जल का अधिक दोहन करता है, भूमि के मूल्य को कम करता है, इसके कारण आस–पास प्राकृतिक वनस्पति का नष्ट होना आदि भी इस वर्ग की अस्पष्ट धारणाओं के कारण भी है। वास्तव में ग्रामीण लोग भी इस वृक्ष के महत्व को अच्छी प्रकार से जानते है। ग्रामीण क्षेत्रो में यह वृक्ष 70 प्रतिशत जलाऊ ईंधन की पूर्ति करता है। भारत में इस वृक्ष का आगमन आज से 144 वर्ष पूर्व हुआ था तथा इस वृक्ष को गम्भीरता से उगाने का प्रयास 1878 से प्रारम्भ हुआ। इस वृक्ष की तेजी से बढने तथा सूखा सहन करने की क्षमता के कारण, यह भारत के अनेक जलवायुवीय क्षेत्रों में तेजी से फैला और आज यह देश के उत्तर में पंजाब से लेकर दक्षिण तमिलनाडु तक तथा पश्चिम में कच्छ से लेकर पूर्व में बिहार तक पाया जाता है। उष्ण कटिबन्धीय जलवायु का यह वृक्ष शुष्क एव अर्ध–शुष्क क्षेत्रीय मैदानों में एवं घाटियों में मुख्य रूप से पाया जाता है। 1940 में इस वृक्ष को तात्कालीन जोधपुर रियासत द्वारा "शाही वृक्ष" का दर्जा प्राप्त था, जिसके कारण पश्चिमी राजस्थान के मरूस्थलीय जिलो में इसका अधिक प्रसार हुआ । यह वृक्ष दलहनी प्रजाति का है तथा इस पर लगने वाली फलियों में शर्करा, कार्बोहाइड्रेट तथा प्रोटीन प्रचुर मात्रा में पाये जाने के कारण प्राचीन काल में इसकी फलीयाँ मनुष्य भोजन का एक स्त्रोत हुआ करती थी, लेकिन वर्तमान में इसका महत्व मनुष्य की अपेक्षा मवेशीयों के लिए अधिक हो गया है। विलायती बबूल की फलीयाँ में एक बाह्य फल भित्ति, मध्य में गूदेदार मध्य फल भित्ति तथा सबसे कठोर बीजों के चारो तरफ एक रेशेदार अंत फल भित्ति होती है। गुदेदार मध्य फल भित्ति का स्वाद खट्टे–कडवे से लेकर मीठे तक होता है। यह मीठी फल भित्ति मनुष्यों एवं मवेशियों के लिए उपयोग में ली जाती है। इस वृक्ष से मिलने वाली फलियों के उत्पादन में अत्यधिक अंतर पाया जाता है, जोकि प्रति हेक्टर में एक टन से लेकर आठ टन तक प्रति वर्ष तक होती है। इसमें फलियाँ प्रति वर्ष लगती है और इस कारण हम इसे 'अमोघ फसल' भी कह सकते है। एक वर्ष में इसमें फलियाँ दो बार आती है, तथा फलियों की उपज ज्यादा वर्षा वाले वर्ष की तुलना में कम वर्षा वाले वर्ष में ज्यादा होती है। इसकी यही विशेषता इस वृक्ष को पशुओं के लिए बहुपयोगी चारा–दाना प्रदान करने वाला वृक्ष बनाती है।

वर्तमान उप–परियोजना "विलायती बबूल मुल्य श्रंखला पर आधारित मुल्य वृद्धि उत्पाद" एक भारतीय कृषि अंनुसंधान परिषद् की वृहद परियोजना है, जो कि राष्ट्रीय कृषि नवोन्मेशी परियोजना द्वारा वित्तपोषित है। इस परियोजना का समस्त वित्तीय भार विश्व बैंक द्वारा उठाया गया है। इस परियोजना की स्वीकृति का संचालन एक समुह द्वारा किया गया था जिसका नेतृत्व केन्द्रीय शुष्क क्षेत्र अनुसन्धान संस्थान (काजरी) द्वारा उत्पादन से उपयोग तंत्र (पी सी एसः भाग II) के अर्न्तगत किया गया। समूह के अन्य भागीदार संस्थान नेशनल फूड प्रोडक्ट्स (भारत), जोधपुर तथा डेजर्ट एनवायरमेन्टल कंजरवेशन एशोशियेसन (डेको), जोधपुर रहे। इन संस्थानों के अतिरिक्त उप–परियोजना के संचालन में स्वेच्छिक भागीदारों अमृत एग्रो इण्डस्ट्री, बासनी, जोधपुर एवं ट्रॉन्सटेक ग्रीन पॉवर प्राइवेट लिमिटेड, चितलवाना, सांचोर ने भी बहुत सी सक्रिय भागीदारी निभायी।

परियोजना लागू करने के लिए जालौर जिले के चार गाँव क्रमशः लालपुरा, सायरा ढाणी, खानपुर तथा गजपुरा का चुनाव किया गया था, क्योंकि इन गाँव में विलायती बबूल बहुतायत में पाया जाता है। परियोजना लागू करने के डेढ़ साल के मूल्यांकन से यह अनुभव हुआ कि केवल लालपुरा एवं सायरा ढाणी गाँवों के किसानों ने ही परियोजना के उद्देश्यों में अधिक रूचि दिखाई, इसलिए परियोजना के बचे हुए वर्षो में कार्यो को केवल इन्हीं दोनों गाँव पर केन्द्रित किया । इसके अतिरिक्त इन दोनो गाँवों का ट्रॉन्सटेक ग्रीन पॉवर लिमिटेड से नजदीक स्थित होने का फायदा भी इस उप–परियोजना को इन गाँवों में लागू करने में सहायक सिद्ध हुआ। इस उपपरियोजना के मुख्य उद्देश्यों का संक्षिप्त वर्णन नीचे दिया गया है।

- वनवर्धयनीय एवं वृक्ष घनत्व प्रबन्धन का परिस्करण को प्रमाणित करना जिसे उच्च शर्करा वाली फलियों का अधिक उत्पादन मिल सके।
- सस्ता पशु आहार (बांटा) बनाने कि विधियों को विलायती बबूल मिश्रण मिला कर और उत्कृष्ट करना।
- विलायती बबूल निर्मित मानव उत्पादों का विकास तथा बनाने कि विधियों उत्कृष्ट करना तथा उत्पादों के भौतिक–रासायनिक गुणों का विश्लेषण करना।

- वर्तमान में पशु चारे के लिए काम में ली जा रही बबूल की फलियों तथा फलियों से बने उन्नत पशु एवं मानव उत्पादों द्वारा ग्रामीण लोगों की आय एवं सामाजिक जीवन पर पड़ने वाले प्रभाव का अध्ययन करना।

परियोजना को प्रारम्भ करने से पहले सांचोर तहसील के लालपुरा एवं सायरा ढांणी एवं भीनमाल तहसील के गजपुरा, खानपुरा, मोलिया, मनडारा गाँवो में एक आधारभूत सर्वेक्षण किया गया था। इन गाँवो की सार्वजनिक चारागाहों, राजस्व भूमि, पड़त भूमि, खेतों की सीमाओं पर विलायती बबूल बहुतायत में उगा हुआ था। सर्वेक्षण से पता चला कि इन गाँवों के अधिकतर किसान लघु एवं सीमंत है। आजीविका के लिये इन गाँवों के लोग पशु आधारित मिश्रित खेती करते थे तथा जलाऊ लकड़ी के लिये विलायती बबूल काम लेते थे। बबूल की झड़ी हुई फलियों में जानवर चराई कराते थे हांलाकि उनको इन फलियों के बहु उपयोगों की जानकारी नहीं थी। बहुत से किसान इस बबूल की लकड़ी से चारकोल भी बनाते थे, जो कि पर्यावरण कि दृष्टि से उचित नहीं है। इन गाँवो मैं रहने वालो लोगो कि आय 3500 रूपये से लेकर 4000 रूपये प्रति महिना प्रति घर थी। इस उप–परियोजना की गतिविधियों की योजनाओं में तथा उनको लागू करने का काम पूर्ण रूप से एक भागीदारी प्रथा पर आधारित था। उप–परियोजना की मुख्य उपलब्धियाँ इस प्रकार से है।

- राजस्थान एवं गुजरात के शुष्क एवं अर्द्ध–शुष्क, दोनों के प्राकृतिक रूप से उगे 45 वृक्षों संरचना (45 स्टेन्ड्स) में फलियों की आकारिकी तथा फलियों के जैव–रासायनिक गुणों का विशलेषण किया गया। इस अध्ययन का मुख्य निष्कर्ष यह निकला कि बीज की लम्बाई का बीज की चौडाई, फली के गुद्दे की चौडाई, तथा गुद्दे में पाये जाने वाली शर्करा से बहुत घनिष्ठ सम्बन्ध था। बीज की मोटाई का सम्बन्ध फली में पाये जाने वाले कुल घुलनशील शर्करा से होता है।
- काजरी जोधपुर के अनुसन्धान फार्म पर 300 विलायती बबूल के वृक्ष जिनका तना सीधा हो लगाये गये तथा 200 वृक्ष जिनमें केवल एक ही तना हो को गाँव लालपुरा में किसानो के खेतों पर लगाये। इस रणनीति से यह फायदा हुआ कि जो वृक्ष खरपतवारों की तरह उगते थे वे अब वैज्ञानिक प्रबन्धन से लगे हुए है, जिनमें विभिन्न कृषि क्रियाओं को आसानी से कि जा सकता है और वृक्षों से अधिक फल उत्पादन में भी सहायता मिली।
- कांटे रहित विलायती बबूलों का एक समुह काजरी जोधपुर के अनुसन्धान के फार्म पर भी लगाया गया, जिनसे मिठी फलीयों का उत्पादन होने लगा। इस वृक्ष समुह मे लगभग 2000 वृक्ष है, और इनकी औसत ऊँचाई 3.1 मी प्रति वृक्ष तथा तने के आधार का क्षेत्रफल 1.40 सेमी^{2}/वृक्ष हो गया है।
- विलायती बबूल की फलियों से उसके मध्य फल भित्ति का चूर्ण–पाउडर, रेशा तथा बीज का खोल अलग–अलग करने के लिए केन्द्रीय कृषि अभियांत्रिकी संस्थान भोपाल से दो थ्रेसर खरीदे गये और इन मशीनों में आवश्यक संशोधन करके इन थ्रेसरों के माप दण्डों तथा मशीनों के ढोल साफ करने वाली इलनी आदि का मानवीकरण किया गया । इन संशोधित थ्रेसरों की प्रसंस्करण क्षमता 60–70 किलो फलियों प्रति घंटा है। इन थ्रेसरों से फलियों के प्रसंस्करण से मिलन वाले उत्पादों में 37–54 प्रतिशत भाग अन्तः फल भित्ति तथा बीज का खोखा था, 19–31 प्रतिशत गुदेदार फल भित्ति का पाउडर व 14–36 प्रतिशत बाह्य फल भित्ति थी, कुछ भाग प्रसंस्करण के दौरान नष्ट हो जाता है, इस थ्रेसर मशीन ने मनुष्य एवं मवेशियों के लिए विभिन्न उत्पाद बनाने में काफी मदद की।
- विलायती बबूल की फली से विभिन्न पशु आहार बनाने वाली तकनीकी को विकसित किया गया तथा उसको और अधिक परिस्कृत किया गया । फली मिश्रित पशु आहार का प्रभाव जानने के लिए एक प्रयोग दूध देने वाली थारपारकर नस्ल की गायों पर दीर्घ काल तक किया गया, जिससे यह पता चल सके की इस पशु आहार से गायों के शारीरिक, रूधिर सम्बन्धी जैव रासायनिक गुणों एवं गायों के दुग्ध उत्पादन और उनके प्रजनन पर इसका क्या प्रभाव हुआ ? प्रयोग के परिणामों से पता चला की फली मिश्रित पशु आहार खिलाने से गायों के दैनिक दुग्ध उत्पादन में बढ़ोतरी हुई, साथ ही साथ उनके प्रजनन काल का अंतराल भी लम्बा रहा । प्रयोग से यह निष्कर्ष निकला कि विलायती बबूल की फलियों को खिलाने से गायों के दुग्ध उत्पादन तथा उनके प्रजनन पर किसी भी प्रकार का कोई हानि कारक प्रभाव नही पड़ता है।
- विलायती बबूल की फलियों से निर्मित आहार बट्टिका बनाने वाली तकनीकी को ओर अधिक परिष्कृत किया गया। फलियों में पाये जाने वाले सुपाच्य कार्बोहाइड्रेट तथा ऊर्जा इस वृक्ष की फलियों को मवेशियों के लिये रूचिकर बनाती है। पशु पालक पशु आहार में इन सस्ती फलियों को मिलाकर पशुआहार के मंहगे घटको को कम कर सकते है। विलायती बबूल फली मिश्रित आहार बट्टिकाओं का प्रभाव दूध देने वाली गायों पर जानने के लिए प्रयोग देशी तथा संकर नस्ल की गायों पर नागौर जिले में तीन महिने तक किया गया । जिन मवेशियों/गायों को आहार बट्टिका खिलाई गई उनके दुग्ध उत्पादन तथा पशु स्वास्थ्य पर किसी प्रकार के नकारात्मक प्रभाव दिखाई नहीं दिया।

- इसी प्रकार से पशु आहार बट्टिका का प्रभाव मारवाड़ी एवं परबतसरी बकरियों पर भी किया गया जिसमें एक समूह बबूल फली मिश्रित आहार बट्टिका तथा नियन्त्रित समुह को इस बट्टिका से वंचित रखा गया । प्रयोग के परिणामों से पता चला कि बकरियों को हिमोग्लोबिन, कुल प्रोटीन तथा रूधिर में पाये जाने वाले यूरिया कि सीमायें शारीरिक सीमाओं के अर्न्तगत की थी । बकरियों का शारिरिक विकारों से दूर रखने के लिए गेंहूँ की चापड़ के बजाय, 30 प्रतिशत तक बबूल की फलीयों का सुरक्षित उपयोग किया जा सकता है।
- विलायती बबूल की फलियों की गुदेदार मध्य फल भित्ति पाउडर से विभिन्न प्रकार के उत्पाद यथा कसर पाउडर, डोनट, बिस्किट तथा लड्डू मनुष्य के प्रयोजन के लिए बनाये गये है तथा बनाने के विधियों का स्पष्ट मानवीकरण किया गया।
- मनुष्य के लिये अधिक मूल्य वर्धक उत्पाद यथा इन्सटैन्ट जुली कॉफी को बनाने के विधि का शोधन किया गया उसको अधिक उत्कृष्ट बनाया गया तथा उसका मानवीकरण किया गया। जुली कॉफी के भौतिक एवं रासायनिक गुण बाजार में उपलब्ध कॉफी के सामान थे, केवल कॉफी में मिलने वाले केफीन को छोड़कर, जिसकी मात्रा जुली कॉफी में बहुत कम थी। इन्सटैन्ट जुली कॉफी के लिए फली की गुदेदार मध्य फल भित्ति को काम लिया गया था तथा बनाने के लिए इसे पहले भूना गया। भूनने का अंतिम बिन्दू जानने के लिए एक छाया कार्ड विकसित किया गया था। इन्सटैन्ट जुली कॉफी के इंद्रिय ग्राफी परख से पता चला कि इसमें वही स्वाद एवं खुशबू थी जो कि बाजार में मिलने वाली कॉफी में होती है। इस जुली कॉफी बनाने के लिये 70 प्रतिशत मध्य फलभित्ति, 10 प्रतिशत कासनी के बीज तथा 20 प्रतिशत परम्परागत कॉफी को काम में लिया गया है।
- इन्सटैन्ट जुली कॉफी के व्यवसायिक उत्पादन के लिये इसके सुरक्षा मानवों की परख नेशनल इन्सटीट्यूट ऑफ न्यूट्रीशन, हैदराबाद द्वारा इसके घटकों फली पाउडर तथा मध्य फलभित्ति को भली प्रकार परखा गया। इस उत्पाद के घातक एवं कम घातक परिणामों का प्रभाव चूहों पर किया गया। दोनों प्रकार के परिणामों से यह निष्कर्ष निकला कि फली पाउडर तथा मध्य फलभित्ति मानव स्वास्थ्य के लिये किसी प्रकार से घातक नहीं है। इन्सटैन्ट जुली कॉफी बनाने की विधि तथा प्रयोग लिये गये सभी कच्चे आंकड़े, दस्तावेज रजिस्टर, नमूने, स्लाइड्स, समाचार, आदि को गोपनीय रखा गया है तथा उनको हैदराबाद स्थित संस्थान में सूचिबद्ध कर दिया गया है।
- विलायती बबूल फली से निर्मित शरबत तथा आटा बनाने कि विधि को विकसित किया गया है। यह पूरक उत्पाद घर पर भी आसानी से बनाये जा सकते है। चयनित गाँवों के लोगों को इस भोजन पूरक उत्पादों बनाने के लिए दक्ष भी किया गया है और उन में से कुछ लोग अपने घरों में इनको बनाकर अपने आहार में सम्मिलित भी कर चुके है। विभिन्न प्रकार के मीठे खाद्य पदार्थ बनाने के लिये आवश्यक किण्विक करण के लिये फली निर्मित आटे को काम में लिया जा रहा है।
- वर्तमान में विलायती बबूल की फलियों की उपयोगिता को लेकर एक बानगी सर्वेक्षण किया गया था, जिससे सामने आया कि ज्यादातर ग्रामीण इसकी फलियों को पशु चारे के रूप में प्रयोग में नहीं लेते हैं, क्योंकि ग्रामीणों को इसके उपयोग के बारे में ज्ञान नहीं था। केवल चराई पर जाने वाले मवेशी ही इसकी फलियों को खाते है।
- विलायती बबूल की फली ही इससे बनने वाली सभी मूल्य वृद्धि उत्पादों के लिये एकमात्र एवं महत्वपूर्ण घटक है। ग्राम लालपुरा, तहसील साचौर, जिला जालौर के प्राथमिक भागीदारो (ग्रामीणो) को मिली सतत् प्रेरणाओं, प्रशिक्षणों से इस वृक्ष कि फलियों को संग्रह करने में सफलता मिली, जोकि मूल्य वृद्धित उत्पादों को बनाने में सहायक सिद्ध हुई।
- लालपुरा एवं सायरा ढाणी गाँवों में एक–एक पौधशाला भी इस वृक्ष के लिए स्थापित की गई है। वर्ष 2011, 2012 एवं 2013 के दौरान इस पौधशालाओं में मीठी फली वाले विलायती बबूल के लगभग 10,000 पौधे तैयार किया गये। तैयार पौधों को परियोजना के स्वैच्छिक भागीदार फर्म ट्रॉन्सटेक ग्रीन पॉवर लिमिटेड, चितलवाना, सांचौर को किसानों द्वारा प्रति पौधा 5 रूपये में बेचा गया। इस प्रकार किसान समुह ने दोनों पौधशालाओं से 5 लाख रूपये कमाये। इस गतिविधि से किसानों को अतिरिक्त आय कमाने का एक स्त्रोत मिल गया।
- उप–परियोजना के लक्ष्यों एवं उद्देश्यों को पूरा करने के लिये प्राथमिक भागीदार किसानों की दक्षता तथा कार्य क्षमता को प्रक्षेत्र दिवसों को आयोजन, ऑफ कैम्पस, ऑन कैम्पस तथा ग्रुप डिस्कसन के माध्यम से बढ़ाया जा सकता है। परियोजना काल मे कुल 15 प्रक्षेत्र दिवसों, 11 ऑन कैम्पस तथा ऑफ कैम्पस परिक्षणों एवं 6 ग्रुप डिस्कसन का आयोजन चयनित गाँवो में किया गया। इनके अतिरिक्त परियोजनों काल में तीन वृहत राष्ट्रीय कार्यशालाओं का आयोजन भी किया गया । प्रथम कार्यशाला विलायती बबूल : भूत, भविष्य एवं वर्तमान का आयोजन काजरी जोधपुर में 23–24 मार्च 2011 को, द्वितीय कार्यशाला ''विलायती बबूल का उपभोग : चुनौतियां

और अवसर'' का आयोजन काजरी जोधपुर में 12–13 मार्च 2012 तथा तृतीय कार्यशाला ''विलायती बबूल : सिहावलोकन एवं संभावना'' का आयोजन काजरी शाखा कुकमा, भुज में 26–28 फरवरी 2013 को किया गया।

- विलायती बबूल की फली से निर्मित सस्ते पशु आहार मिश्रण, इन्सटैन्ट जुली कॉफी, पशु आहार बट्टिका तथा सम्पूर्ण पशु आहार बट्टिका को बनाने के लिये आवश्यक विधियों को विकसित किया गया तथा इन विधियों को ओर अधिक विस्तृत भी किया गया विलायती बबूल के बीज से गोंद निकालने कि तकनीकी, खाने योग्य प्रोटीन, मेस्क्यूटोल (एक प्रकार का एण्टी–ऑक्सीडेण्ट) तथा फली से शरबत एवं बारीक आटा बनाने की तकनीकी एवं वृक्ष से गोंद निकालने की तकनीकियों को विकसित किया गया।
- ग्रामीणों की आजीविका मे सुधार के लिए एक पब्लिक–प्राइवेट पार्टिसिपेटरी मॉडल को विकसित किया गया। चयनित गाँव के समीप ट्रान्सटेक ग्रीन पॉवर लिमिटेड द्वारा एक बिजली बनाने के संयन्त्र की स्थापना की गई है। इस छोटे संयन्त्रमें बिजली उत्पादन के लिए विलायती बबूल को काम मे लिया जाता है। प्रारम्भ में इस संयन्त्रकी स्थापना फसल अवशेषों को लेकर बिजली उत्पादन करना था, परन्तु इन फसल अवशेषों से केवल तीन महीने तक ही बिजली उत्पादित की जा सकती थी, क्योंकि फसल अवशेषों की आपूर्ति केवल तीन महिनों की होती थी। हमारे आग्रह करने पर संयन्त्रमालिक ने ग्रामीणों से विलायती बबूल की पतली टहनियां खरीदना प्रारम्भ कर दिया तथा बदले में किसानो को डीजल चलित पॉवर करोत (पावर सौ) उपलब्ध कराई गयी। इस प्रकार चयनित गाँव के लोग बिजली संयन्त्र को बबूल की टहनियां उपलब्ध कराने लगे । संयन्त्र को प्रचुर मात्रा में कच्चा माल विलायती बबूल से मिलने के कारण इसकी क्षमता में अत्यधिक वृद्धि हुई अब इस संयन्त्र से 10 मेगा वाट बिजली का उत्पादन साल भर होने लगा है। इस संयन्त्रकी सफलता से आसपास के ग्रामीणों की आय में भी वृद्धि होने लगी। इस प्रकार हम कह सकते है कि दोनों पक्षों के लिये यह फायदे का सौदा साबित हुआ। इस पब्लिक–प्राइवेट पार्टनरशिप मॉडल की सफलता का अध्ययन करने के लिये कीनिया से वानिकि विशेषज्ञों का समूह भी आया, जिससे वह हमारे तर्ज में, इस वृक्ष को अपने देश के ग्रामीण लोगो की आजीविका के सुधार के लिये और अधिक सफल बना सके।
- राजस्थान राज्य इन्डस्ट्री को भारतीय लघु इन्डस्ट्री विकास बैंक द्वारा लाल, नांरगी तथा हरे वर्गो में विभाजित किया गया। वर्तमान में उल्लेखित राष्ट्रीय कृषि नवोन्मेषी परियोजनों की इस उप–परियोजना में केवल लघू इन्डस्ट्री को ही लिया गया है, जोकि हरे वर्ग से आती है। हरे वर्ग में वर्गीकृत इन्डस्ट्री को किसी भी प्रकार की पर्यावरणीय रिपोर्ट जमा करने की आवश्यकता नहीं होती है। इस उप–परियोजना का सभी सामाजिक पहलुओं पर सकारात्मक प्रभाव रहा है। इसी प्रकार से परियोजना का पर्यावरण पर प्रभाव भी सकारात्मक ही रहा है।

इस उप–परियोजना की जो मूल्य श्रंखला विकसित कि गई उसमे फलियों का संग्रहण, चयनित गाँवों से प्राथमिक मूल्य वर्धन करना, इन प्राथमिक मूल्य वर्धित उत्पादों को गाँव से काजरी संस्थान तथा इन्डस्ट्रीज को उपलब्ध कराना तथा जहाँ जरूरी हो वहाँ तकनीकि हस्तक्षेप करना शामिल है। इस मूल्य से श्रंखला कुल 13,325 मानव दिवसों का प्रति वर्ष सृजन हुआ, जिसमें बिजली संयन्त्रको माल उपलब्ध कराने वाले मानव दिवस भी शामिल है।

Executive Summary

The value of *Prosopis juliflora* for providing many much needed resources for the poor is generally accepted, with views for and against *P. juliflora* coming from different quarters. The popularity of *P. juliflora* is income related, those that can afford bottled gas for cooking and do not have to raise livestock quickly forget its value as a fuel and fodder tree. Comments concerning its monoculture, lack of aesthetic value and unconfirmed beliefs on the lowering of water tables come only from the more affluent. Rural farmers are invariably aware of its importance and acknowledge these trees for their benefits. In contrast to negative views of *P. juliflora* as a weed, it provides up to 70% of the firewood needs of rural populations in dry regions in India. The history of first introduction of *P. juliflora* into India is about 144 years old. Introduction of the species was first seriously attempted in 1878. Owing to its fast growth and draught hardness, the species has been introduced in many parts of India and today the species is distributed from north- west to south from states of Punjab to Tamil Nadu and in east-west direction it is found from Kuchh region of Gujarat to drier parts of Bihar. The domain of the species in arid and semi- arid tropical region is mostly in plain and valleys. It was declared a 'Royal Plant' in Rajasthan in 1940, being promoted as a useful and productive species for the arid zone.

The fruit produced by *Prosopis* species are legume pods, high in sugars, carbohydrates and protein. Pods have been a historic source of food for human populations where *Prosopis* species are found, increasingly becoming less important as a human food and more important as a livestock feed. Pods of *P. juliflora* are composed of an exocarp, fleshy mesocarp, fibrous endocarps and hard seeds. The mesocarp varies in taste from tart and bitter to the sweet preferred for human and animal consumption. Per hectare production of pods of the species is highly variable ranging from 1 to 8 t/ha/year. *P. juliflora* produce fruit every year and can be termed an 'unfailing crop' They produce a greater yield of pods in years of below average rainfall but may produce low yields of pods in very wet years. Fruiting occurs twice in a year in India and this characteristic make them very suitable as a source of food and/or fodder.

The present project "Value Chain on Value Added Products Derived from *Prosopis juliflora*" was funded by National Agriculture Innovative Project (NAIP), a mega project of ICAR financed by World Bank. This project was sanctioned to Central Arid Zone Research Institute, Jodhpur led consortium under production to consumption system (PCS; Component-II). The other partners of consortium are National Food Products (India), Jodhpur and Desert Environmental Conservation Association (DECO), Jodhpur. In addition to said partners, the sub-project has too very active voluntary partners viz., Amrit Agro Industry, Basni, Jodhpur and Transtech Green Power Private Ltd., Chitalwana, Sanchore.

To implement the project four villages in Jalore district viz., Lalpura, Sayara Dhani, Khanpur and Gajpura were selected because *P. juliflora* was in abundance around these villages. After one and half years experience it was observed that the farmers of village Lalpura and Sayara Dhani are much more active than other villages and therefore, much of the further work was concentrated on said two villages. Moreover, Lalpura and Sayara Dhani were located in Chiltawana *Panchayat Samiti*, we got added advantage of their nearness to Transtech Green Power Pvt. Ltd., a highly active voluntary partner of our sub-project. The sub- project has following four major objectives:

- Refinement of standardized silvicultural and tree stand management practices for production of pods having high sugar content.
- Refinement in developed process of preparing cheaper concentrate ration by inclusion of *Prosopis* pods for livestock.
- Development and refinement of human food products prepared by *Prosopis* pods having high and low sugar content and their physico-chemical analysis.
- Study of the present use of *Prosopis* pods and impact of various developed feed and food products on the economy of rural people and also pricing, marketing and social aspects of *Prosopis* product's value chain**.**

A baseline survey was conducted in village Lalpura, Sayara Dhani (Tehsil- Sanchore of Jalore district), Gajpura, Khanpura, Golia. Kotra and Mandhara (Tehsil- Bhinmal of Jalore district*).* *P. juliflora* was in abundance on village CPR, revenue lands, other waste lands and on boundary of farmers' fields in all the villages. The survey reviled that maximum households belonged to marginal and small farmers' class. Farming is mixed crop-livestock based and *P. juliflora* is used by all the households for fire wood purpose. Farmers also allow their livestock to graze on fallen pods of *P. juliflora*, however, they had no idea of multi-purpose use of the species. Many farmers are engaged in preparation of charcoal by using wood of the species, which is not an environment friendly enterprise. On an average, across different income groups, the average income of households was in the range of Rs 3500-4000/ month. The sub-project activities was planned and executed through absolute participatory approach. The salient achievements of the sub-project are as under:

- Assessed relationship among tree structural, pod morphological and pod biochemical traits by studying 45 natural stands of the species in selected arid and semi-arid areas of Rajasthan and Gujarat. The major finding of the exercise was that seed length had significantly positively co-relation with seed width, seed thickness and total soluble sugar in pod pulp. The seed thickness also had positive co-relation with total pod soluble sugars.
- Three hundred trees of *P. juliflora* were managed to make straight bole plant type at CAZRI, Jodhpur's Research Farm and similarly, 200 plants of *P. juliflora* were managed to make them as clear bole plant type at target sites Lalpura. This management strategy transformed weedy growth of plant in to managed plantation for higher pod production and easy collection.
- A block plantation of non-thorny sweet pod bearing plant type of *P. juliflora* has been established at CAZRI Research Farm. It contains 2000 plants, which have on an average attained height of 3.1 m/ tree and mean basel cover 1.40 cm^2/ tree.
- Two experimental plot threshers were procured from CIAE Bhopal and modified the machine parameter like threshing drum and agitating sieves speed was optimized to extract different components from *P. juliflora* pods viz. mesocarp powder (good source of sugar), epicarp (fiber) and endocarp with seed. The modified machine processing capacity was in order of 60-70 kg pods/hr. The output of the machine in terms of different component from *Prosopis juliflora* pods, 37-54% endocarp with seed, 19-31% mesocarp powder, 14-36% epicarp (fiber), about 1-5% loss in the form

of fine particles, dust and weight loss due to moisture, etc. This modified plot threshers opened the door for production of *P. juliflora* pod based products for livestock and human consumption.

- The technology was developed and perfected to process *P. juliflora* pod based livestock feed. It has been commercialized also, through in a local scale. A long term replicated experimentation was conducted on lactating *Tharparker* cattle to study the impact of the *P. juliflora* pod based processed feed on their production and reproduction status by addressing range of physiological and hemato-biochemical issues. The experimental results confirmed milk yield of cattle fed on *Prosopis juliflora* pods containing concentrate mixture increased significantly however, the calving interval of the cattle which were fed on *P. juliflora* pod based feed was also extended. The results indicated that *P. juliflora* pod based feed had no adverse effect on health, reproduction and production of lactating *Tharparker* cattle.
- The technology was perfected to process *P. juliflora* pod based feed blocks. *P. juliflora* pods are palatable feeds and good sources of energy for ruminants due to their digestible carbohydrate content. They can replace costly part of the diet grains to make the concentrate feed cheaper. A field trial was conducted on ten lactating indigenous and crossbred cows selected from villages of Nagaur district for a period of three months. Selected animals did not show any health problem after consuming these blocks and persistency of milk yield was maintained for the entire period of field trial.
- A replicated long term experiment was conducted on *Marwari* and *Parbatsari* goats by feeding them with *P. juliflora* pod based feed block with suitable control to assess the impact of such feed block on their health status. Values of hemoglobin, total protein and blood urea nitrogen were within the physiological limits. Results indicated that *P. juliflora* pods can safely be used in place of wheat bran up to 30% in concentrate feed to improve body weight gain of growing goats without compromising health status.
- Using pod flour (mesocarp fraction) of sweet pod bearing plant type of *P. juliflora,* techniques for preparing human food products viz., *Cussar* powder, *doughnuts*, biscuits and *ladoos* have been standardized.
- Technology was standardized, refined and perfected for highly value added human use product "Instant Juli Coffee", a coffee substitute. Physico- chemical characteristics of Instant Juli Coffee were more or less similar to conventional coffee (*Coffee robusta*) except that caffeine was present in very low quantity in Instant Juli Coffee. Roasting of *P. juliflora* pod mesocarp is the main process for processing Instant Juli Coffee and therefore, to know the exact roasting end point, a shade card was developed. Organoleptic evaluation of Instant Juli Coffee revealed that best combination which gives same taste and aroma that of conventional instant coffee was 70% roasted mesocarp of *P.juliflora* pods, 10% chicory powder and 20% powder of conventional roasted coffee beans.
- For commercial production of Instant Juli Coffe. Food safety standards of *P. juliflora* whole pod powder and mesocarp was examined by NIN, Hyderabad. The acute and

sub-chronic toxicity analysis test was conducted on rats and mice using whole pod powder and mesocarp. Both the tests clearly indicated that the commodities are safe for human consumption. All raw data, documentation, records ,specimens ,slides ,protocols generated in the study have been kept confidential, inventoried and archived in Archives room by Archiving officer at NIN, Hyderabad.

- Technology for processing *P. juliflora* pod based syrup and fine flour have been developed. Food supplement can be processed at household level. Villagers in target sites have been trained and many of them are using Juli syrup in their diet. Fine flour is highly suitable as a leavening agent for confectionary items.
- Sample survey of the study of present use of pods of *P. juliflora* indicated that they are not used at all as villagers had no knowledge regarding use of pods in livestock feed. However, free roaming cattle and small ruminants eat fallen pods frequently.
- Pod is a critical and sole important for developing the value chain of value added products of *P. juliflora*. Continuous motivation of primary stakeholders through field trainings regarding collection and grading of *Prosopis* pods resulted in establishment of pod collection and field training centre by the efforts of villagers in Lalpura village, tehsil Sanchore, district Jalore.
- Two farmers' nurseries were established in target villages one at village Lalpura and another at Syara Dhani. In each nursery more than 10,000 seedlings of sweet pod bearing *Prosopis* plant types were raised during year 2011, 2012 and 2013. Farmers' sold these seedlings to our voluntary partner Trans-tech Green Powder Ltd. Chiltawana, Sanchor at the rate of Rs. 5/ seedling. Thus, every year participating farmers' group of each village earned Rs. 50,0000 (Rs 1.00 lac from two nurseries). This activity has high potential for extra income generation source for primary stakeholders.
- Organization of Field days, off and on-campus trainings and group discussions are effective means for skill development and capacity building of farmers', the primary stakeholders for achieving the goals of the sub-project. During the course of present NAIP sub-project 15 field days, 11 on and off-campus trainings and 6 group discussions were organized at target villages sites and other potential sites. In addition during the course of present NAIP sub-project, three mega National Workshops were organized first workshop entitled **"*Prosopis juliflora*: Past, Present and Future"** was organized at CAZRI, Jodhpur from 23rd to 24th March, 2011; Second National Workshop entitled "**Utilization of *Prosopis juliflora*: Challenges and Opportunities**" was organized on 12th and 13th March, 2012 at CAZRI, Jodhpur; and third National Workshop entitled "***Prosopis juliflora*: Retrospect and Prospects** "was organized at CAZRI, Regional Research Station, Kukma, Bhuj from 26th to 28th February, 2013.
- Production technologies for processing *P. juliflora* pod based cheaper concentrate mixture (feed), instant juli coffee, multi- nutrient feed block and complete feed block have been developed and perfected. Process technologies for extraction of *Prosopis* seed gum (similar to Guar gum), edible protein, mesquitol (a very powerful anti-

oxidant), *P. juliflora* pod based syrup and fine flour and *P. juliflora* exuded gum production have been developed.

- Public- private participatory model for up-lifting rural economy was developed. Transtech Green Power Limited, established a electricity generation plant at Chitlawana, Sanchore, district, Jalore (near to our target villages at Sanchore). The plant is a small scale unit, which is generating electricity using biomass. The concept was to generate electricity by using crop residue. However, when plant was commissioned and started generating electricity, it was found that crop residue available is sufficient for only three months. We suggested them to ask villagers to cut the side stems from *P.juliflora* thickets and leave 2 or 3 central stems of good diameter (5.0-6.0 cm). On our request Transtech Green Power Limited provided diesel driven power saws to our groups of farmers. The farmers of our target villages started supplying *P. juliflora* wood to power plant. The availability huge amount of *P. juliflora* wood has become a boon for the plant and it started generating 10 MW electricity 24 hrs/ day year round. On the other hand farmers received good amount of money by the sale of *P. juliflora* stems. Thus, this has been a win- win situation for all partners. A delegation of forestry expert from Kenya visited CAZRI, Jodhpur to study this public- private participatory model because this activity also provided a scope of *P. juliflora* management in addition to up-lifting the livelihood of the rural community.
- According to small industry development bank of India report of 2012 for Rajasthan, Industries are classified into Red, Orange and Green categories. In the present NAIP sub-project only very small industries are involved which belonged to green category. The industries of green category need not to submit any environmental safeguard reports. In our sub-project all the social aspects had positive effects. Similarly, all the activities of the project were environmental friendly.
- The value chain developed in the sub-project involved organized collection of pods, primary value addition centre at a target village, supply of PVA pods from this centre to institute and industry, and interventions at various point and components. Total employment generation from the value chain was in order of 13325 man days/ year including fresh twigs of *P. juliflora* sold to biomass power generating plant.

Key words: acute and sub-chronic toxicity, consortium, feed block, impact, industry, instant juli coffee, mesocarp, multi nutrient feed block, national workshop, pod, pod flour, process technology, production technology, *Prosopis juliflora*, *P.juliflora* pod based cheaper concentrate mixture (feed), sweet pod bearing plant type, value chain, voluntary partner.

Part-I: General Information of Sub-project

1. Title of the sub-project: Value Chain on Value Added Products Derived from *Prosopis juliflora*
2. Sub-project code: 20013
3. Component: II
4. Date of sanction of sub-project: September,2008; Funds released in Nov.,2008; launched on 6th January,2009
5. Date of completion: 31st March, 2014
6. Extension if granted, from April, 2012 to March, 2014
7. Duration of the sub project: 2008-09 to 2013-14
8. Total sanctioned amount for the sub-project: Rs. 199.836 lacs
9. Total expenditure of the sub-project:
10. Consortium leader: Dr. M. M. Roy, Director, Central Arid Zone Research Institute, Light Industrial Area, Jodhpur-342003, Phone: 02912786584; Fax: 0291-2788706; Email: director@cazri.res.in

1. **List of consortium partners:**

	Name of CPI/ CCPI with designation	Name of organization and address, phone & fax, email	Duration (From-To)	Budget (`Lakhs)
CPI	**Dr. L. N. Harsh**	**CAZRI, Jodhpur, (P) 0291-2788789, Fax: 0291- 2788706, Email: lnharsh@cazri.res.in**	**From inception to 31st Aug, 2010**	**Rs. 176.286 lacs**
	Dr. J. C. Tewari	**CAZRI, Jodhpur, (P) 0291-2788789, Fax: 0291- 2788706 Email: drjctewari@gmail.com**	**1st Sept. 2010 to 31st March, 2014**	
CCPI-1	**Mr. Prem Raj Parakh, Owner of small scale industry**	**National Food Products (India), Jodhpur (Industrial partner; (P) 0291-2745874**	**From inception to 31st March, 2012**	**Rs. 15.710 lacs**
CCPI-2	**Dr. Shyam Lal Harsh, President, DECO, Jodhpur**	**Desert Environmental Conservation Association (DECO) (NGO partner)**	**From inception to 31st March, 2012**	**Rs. 7.840 lacs**

CPI-Consortium Principal Investigator; CCPI-1; CCPI-2 (Consortium Co- Principal Investigators)

2. **Statement of budget released and utilization partner-wise (` in Lakhs):**

	CPI/ CCPI Name, designation & address)	Total budget sanctioned	Fund released (up to closing date)	Fund utilized (up to closing date)
CPI	**Dr. J. C. Tewari, CAZRI, Jodhpur, (P) 0291-2788789, Fax: 0291- 2788706 Email: drjctewari@gmail.com**	**Rs. 176.286 lacs**	**Rs. 16305709**	**Rs. 16072979***
CCPI-1	**Mr. Prem Raj Parakh, Owner of small scale industry**	**Rs. 15.710 lacs**	**Rs. 14.61500 lacs**	**Rs. 14.61500 lacs**
CCPI-2	**Dr. Shyam Lal Harsh, President, DECO, Jodhpur**	**Rs. 7.840 lacs**	**Rs. 4.34013 lacs**	**Rs. 4.99460 lacs**
Total		**Rs. 199.836 lacs**	**-**	**-**

*Rs. 1678894/- refunded to PIU- NAIP, in financial year 2011-12

CPI-Consortia Principal Investigator; CCPI-Consortia Co-Principal Investigator

Part-II: Technical Details

1. Introduction

The hot Indian arid zone is spread in 31.7 million hectare area of which major part is in northwestern India (28.57 m ha) and some in southern India (3.13 m ha). The arid regions of

Rajasthan, Gujarat, Punjab, and Haryana together constitute Great Indian Desert, better known as *Thar*. Arid western Rajasthan covers 61 % of total hot arid areas of the country and thus, forms the principal hot arid region of the country. Climatic condition of this part of the country is inhospitable. The region is characterized by low rain (100-420 mm/ year), high temperature touching a maximum of 45-49° C in summers, high wind speed (20-40 km/ hour) and high evapo-transpiration (1500-2000mm/ year). The draughts are common phenomena in the region. The soils are structure less and very poor in fertility. The number of tree species growing in the region is too less and their distribution is very sparse. *Prosopis juliflora,* which was first introduce in 1877 in India (in Sindh, then undivided part of India) and in 1913 in arid parts of Rajasthan state, has now spread in almost hot arid and semi-arid region of the country.

With its tremendous ability to adapt in tropical arid and semi-arid environments, and its fast growth and multiple utility, it has long been recognized by the foresters as a versatile species for the afforestation on various land forms of the arid and semi- arid tropics. However, rural population in arid and semi- arid tropics are little apprehensive of the species as they consider that species adversely affects crop production and fear it may become a weed. In fact, the species is catering 70% fire-wood demand of rural population in semi- arid and arid regions, and its raw pods are used as animal feed. With production of fuel wood, pods and straight boles for timber, expectation of *Prosopis juliflora* can be profitable use of otherwise unproductive lands. In countries like, Maxico, Argentina, Peru, Brazil, USA, etc. the processed pod powder is used as a substitute of coffee, pod flour in confectionary, sugary mineral rich concentrate from pod pulp as a substitute of honey, etc. However, in India despite of abundance of *P. juliflora* in arid and semi-arid tropics, the use of pods for value added products of livestock and human consumption was not known.

The present value chain on processing value added products from *P. juliflora* pods for human and livestock consumption was developed to utilize the abundant availability of raw material which was otherwise going waste. If the pods and seeds of the species are used for product processing, the un-controlled invasion of the species could be checked as such fast spread of the species is considered due to migratory animals because the hard coated seed is not digested when animals eat raw pods and seeds come out with feces. Such seeds germinate very fast. A built in programme for pod collection, primary value addition and their marketing at primary stakeholders levels to enhance rural economy and product processing at small scale industry level was the part of project to augment the commercialization and up-scaling of the activities.

2. Overall Sub-project Objectives

- Refinement of standardized silvicultural and tree stand management practices for production of pods having high sugar content.
- Refinement in developed process of preparing cheaper concentrate ration by inclusion of *Prosopis* pods for livestock.
- Development and refinement of human food products prepared by *Prosopis* pods having high and low sugar content and their physico-chemical analysis.
- Study of the present use of *Prosopis* pods and impact of various developed feed and food products on the economy of rural people and also pricing, marketing and social aspects of *Prosopis* products value chain**.**

3. Sub-project Technical Profile

Objective: Refinement of standardized silvicultural and tree stand management practices for production of pods having high sugar content.
Work plan: Employing of thinning, pruning and lopping practices on existing growing stock to increase the pod production under variable density regimes. investigating relationship of pod production Vs various tree morphological structural features, pod structural features and pod biochemical characteristics to understand the impact of particular tree and pod features on pod production. Mass propagation of selected sweet pod plant genotype.
Monitorable Indicators: Enhanced pod production by employing suitable silvicultural practices. Selection of high pod yielding plant type by studying structural features of plant. Promotion of agroforestry through plantation of plant types having pods of high sugar content.
Expected output: Increase in pod production to the tune of 30-40% from managed stands. Primary stakeholder opting for plantation of high pod yielding plant type of the species.
Expected outcome: Large scale utilization of massive pod availability. Increased extra employment and income generation in target sites. Easy supply of fodder in form of milled pod powder during years of low rainfall and droughts.
Objective: Refinement in developed process of preparing cheaper concentrate ration by inclusion of *Prosopis* pods for livestock.
Work plan: Refinement in developed value added cheap feed concentrate using *Prosopis* pod flour. Processing *P. juliflora* pod based complete feed block and multi-nutrient feed block Biochemical and nutritional value analysis of *Prosopis* pod flour and seeds. Feeding trails on cattle and goats with value added developed products to study the effect of these products on general health and milk production.
Monitorable Indicators: New and cheaper value added *P. juliflora* pod based concentrate ration, complete feed block and multi-nutrient block. Improved health status and higher milk production.

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Expected output: Availability of value added nutritious animal feed through replacing costly ingredients used presently, thereby reducing investment of farmers on conventional high priced animal feed. Enhancement in milk production. Increased income of primary stakeholders by collection and marketing of raw pods and ground pods.
Expected outcome: Less dependence on costly conventional feed. Easy availability of alternative source of livestock feed. Reduced expenditure of farmers and other primary stakeholders.
Objective: Development and refinement of human food products prepared by *Prosopis* pods having high and low sugar content and their physico-chemical analysis.
Work plan: Processing of *Prosopis* pod flour for ready to eat human food products *Instant Juli Coffee*, mineral rich sugary concentrate and confectionary items for commercialization, and other commercially important products Nutritional testing and toxicity analysis of processed food products for safety standards.
Monitorable Indicators: Availability of processed food products like coffee substitute (Instant Juli Coffee, etc.) Increased employment and income generation opportunities in processing units and target sites.
Expected output: Increased employment opportunities for different actors involved in pod collection, sale and pod processing for value added products. Capacity building especially that of primary stakeholders.
Expected outcome: Actively involved four groups of 15 household each in target sites will generate extra income around Rs. 2000/ month. Occasional pod and wood collectors earned extra income by way of sale of pods and wood.
Objective: Study of the present use of *Prosopis* pods and impact of various developed feed and food products on the economy of rural people and also pricing, marketing and social aspects of *Prosopis* products value chain.
Work plan: Sample survey of farm households at target sites and assessment of present use of *Prosopis* pods. Popularization of various uses of processed *Prosopis* products through capacity building of all stakeholders. Documentation of supplemental use of *Prosopis* pods in livestock ration and its level of acceptance for human consumption. Assessment of economic feasibility and consumer acceptance of developed products.
Monitorable Indicators: *Prosopis* products both for livestock and human consumption in market through PCS value chain. Organized small scale pod collectors and processors association. Training materials and workshops, trainings, exhibitions, fields days, etc.
Expected output: Availability of information on present use pattern of raw *Prosopis* pods. Additional income and employment generation at the level of all actors. Capacity building of all stakeholders.
Expected outcome: Human resource development for commercial use of *Prosopis* pods. Market chain development through industrialists and entrepreneurs for *Prosopis* pod products. Skill development at the level of all actors.

4. Baseline Analysis of target sites (Total households surveyed 120)

Present use of *Prosopis* pods		**Baseline**
1.	Only raw pod feeding to livestock	25 households
2.	Pod mixed with conventional concentrate ration purchased from market	28 households
3.	Exuded gum collection	14 households
4.	Fuel wood collection for household use	107 households
5.	Pod eating habit among children	67 households
6.	Fuel wood collection for marketing	10 households
7.	*P. juliflora* stand management for higher pod production	00 households
8.	*P. juliflora* tree management for timber production	00 households
Value added *Prosopis* pod based products/ technologies available		
1	Value added livestock products	00
2.	Value added products for human consumption	00
3.	Value added products for industrial uses	00
4.	Extra employment generation through pod collection and marketing	00
5.	Extra income generation through pod collection and marketing	00

5. Research Achievements with Summary

- **Refinement of standardized silvicultural and tree stand management practices for production of pods having high sugar content**

A. Survey of CPT's (Candidate Plus Trees) of *Prosopis. juliflora*

Assessed relationship among tree morphological, pod structural and pod biochemical characteristics in *P. juliflora* by studying 44 natural stands of the species in selected arid and semi-arid tracts for assessment of pod production. Tree morphological, pod structural and pod biochemical attributes were studied. Tree morphological features studied were stem diameter, tree height and crown diameter; pod structural characters included pod weight, pod length, pod width and number of seeds per pod, and seed characteristics included 100-seed weight, seed length, seed width and seed thickness. Biochemical characteristics of the pod for crude protein and total carbohydrates were analyzed.

Of the 78 possible pairs of characters, 13 showed significant positive correlation; while 8 showed significant negative correlation (Table.1). Tree height was significantly and positively correlated with stem diameter and crown diameter, and stem diameter was significantly and positively correlated with crown diameter. Among the pod and seed characters, significant positive correlations were recorded for: pod weight-pod width; pod length-number of seed per pod; 100-seed weight-pod width, seed length, seed thickness and total soluble sugars in pod pulp.

Table 1. Inter-relationship among various tree, pod and seed characteristics in *Prosopis juliflora* (on the basis of CPTs selected from 44 natural stands of the species)

Character	(l)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(1 l)	(12)	(13)
(1) Pod weight	-	0.229	0.289*	0.265	0.283	0.120	0.097	0.138	0.223	-0.126	-0.104	0.065	-0.012
(2) Pod length		-	0.223	0.73J'''	-0.279	-0.217	-0.153	-0.173	-0.193	0.086	-0.137	-0.051	-0.215
(3) Pod width			-	0.D75	0.359*	-0.088	-0.110	0.102	0.254	0.094	*-0.354**	-0.148	-0.195
(4) No. of seeds/pod				-	-0.440'''	-0.530*·	-0.288*	*-0.326**	*-0.434***	-0.060	*-0.023*	-0.125	-0.096
(5) IOO·seed weight					-	0.514**	0.081	0.631**	0.692**	-0.134	-0.157	-0.046	-0.016
(6) Seed length						-	0.537''	0.519**	0.526**	0.143	-0.138	0.058	-0.042
(7) Seed width							-	0.210	0.251	0.116	-0.224	-0.177	-0.300*
(8) Seed thickness								-	0.557**	-0.153	-0.088	-0.035	0.058
(9) % Total sugars									-	*-0.296**	-0.218	-0.018	-0.097
(l 0) % crude protei n										-	-0.094	0.045	-0.189
(l l) Tree height											-	0.485**	0.624**
(12) dbh of tree												-	0.711**
(13) Crown diameter of tree													-

*** p < 0.05. ** p < 0.0 I**

Seed length showed significant positive correlation with seed width, seed thickness and total soluble sugars in pod pulp; and seed thickness with total pod soluble sugars. Significant negative correlation coefficient for pod and seed characters were observed for pod width with tree height; and number of seeds per pod with 100- seed weight, seed length, seed width, seed thickness and total pod soluble sugars, seed width with crown diameter. Total soluble sugars in pod pulp had significant negative correlation with crude protein content; and pod weight had a positive though not significant association with all pod and seed characteristics except protein content of pod pulp. The number of seeds per pod had a significant negative co-relation with all the seed structural attributes.

Impact: *Facilitated selection of improved genotype for higher pod production*

B. Tending operations in *Prosopis juliflora* trees

Three hundred trees of *P. juliflora* were pruned to make the straight bole at CAZRI, research farm. All the side branches were removed and vertical lopping was carried out in middle and lower part of the canopy. A stand of 200 *P. juliflora* plants were also selected in target sites, Lalpura and similar tending operations were carried out on these trees. The exercise was done every year till the end of third year. By that time the plants have assumed clear bole shape with spreading upper canopy. Pod production from unmanaged and managed stands were assessed every year. On an average the pod production in wild stands was around 15kg/ thickets, whereas same was around 25 kg/ tree in managed stand. This 40% increase in pod production was observed in managed stand of target village however, the increase in pos production in CAZRI experimental plot was in the range of 20-25%.

Weedy growth of *P. juliflora*

A managed stands of *P. juliflora* at CAZRI Jodhpur

A managed stands of *P. juliflora* at village Lalpura

Impact: *Weedy growth of plants was transformed into managed plantation for higher pod production and easy collection.*

Plantation of non- thorny sweet pod bearing *Prosopis* plant type

A block plantation of non-thorny sweet pod bearing plant type of *P. juliflora* has been established at CAZRI Research Farm. It contains 2000 plants, which have on an average attained height of 3.1 m/ tree and mean basel cover 1.40 cm^2/ tree. However, the pod bearing has still not started in the plantation. During year December, 2013 first flowering in some plants has been observed. From 2009 to 2013 produced 5000 seedlings of such plant types every year in the nursery and distributed to primary stakeholders of target areas to plant them on filed bunds, village CPRs and on farmers' fields.

A view of plantation of non- thorny sweet pod bearing *Prosopis* plant type

Impact: *expansion of plantation stands of non-thorny and sweet pod bearing Prosopis plant type.*

C. Pod Processing

Two experimental pod threshers were procured from CIAE Bhopal and modified the machine parameter like threshing drum and agitating sieves speed was optimized to extract different components from *P. juliflora* pods viz. mesocarp powder (good source of sugar), epicarp (fiber) and endocarp with seed. The rotation and speed of drum was changed so that most of pods get threshed between concave and pegs/beaters. An open type semicircular concave of the cylinder circumference was fabricated using 5 mm square bar. The screen was made of longitudinal square bars, spaced 8 mm apart to make it perforated for better extraction. Concave clearance was adjusted and fixed at 25 mm at feeding, which decreased up to 10 mm at the other end. Machine was operated at three speed of threshing drum low speed (1000 rpm) suitable to extract mesocarp powder and seed, medium speed (1600 rpm) for seed spilt to use as gum production and high speed (2300 rpm) for hull of seed & fine endocarp suitable to use as animal feed ingredient. The modified machine processing apacity was in order of 60-70 kg pods /hr. The output of the machine in terms of different component from *Prosopis juliflora* pod, 37-54% endocarp with seed, 19-31% mesocarp powder, 14-36% epicarp (fiber), about 1-5% loss in the form of fine particles, dust and weight loss due to moisture, etc. Existing thresher can be utilized for threshing different crops by changing the concave and threshing drum speed. The experiment was carried out to use Hammer mill to make hull and fine particles with sieve of 6 mm size, which was useful for animal feed

ingredient only. Modified machine can be utilized as multipurpose unit and especially for mesocarp powder and seed extraction purpose.

Modified plot thresher for *P. juliflora* pods

To grind large quantity of pods heavy grinder was used. This grinder can process more than 300 kg pods in 8 hrs. The ground pods were compressed. The compressed material was used to prepare feed block by hydraulic block making machine.

Pod grinder

Impact: *opened the door for production of P. juliflora pod based products for livestock and human consumption.*

- **Refinement in developed process of preparing cheaper concentrate ration by inclusion of *Prosopis* pods for livestock.**

A. Productive and reproductive status of lactating *Tharparkar* cattle fed on an easily processed and balanced *Prosopis juliflora* pods based Cheaper Concentrate Mixture containing

Utilizing locally available feed resources a cheaper and balanced concentrate feed mixture for arid region was developed by simply mixing the ground feed ingredients *Prosopis juliflora* pods powder, mustard cake, Guar (*Cyamopsis tetragonaloba*) korma, de-oiled rice bran, common salt, mineral mixture, etc. Farmers' and livestock keepers accepted this production technology as it requires minimum labour and energy inputs to process the concentrate ration (feed). To understand the effect of this animal feed on health and as well as milk production a long term feeding trial on lactating *Tharparkar* cattle was initiated during 2010 which remain continued for almost an year at research cum demonstration unit of *Tharparkar* cattle, KVK, CAZRI, Jodhpur.

Process for preparing *P. juliflora* pod based cheaper concentrate mixture at experimental level

Twelve lactating *Tharparkar* cattle were randomly divided into three groups of 4 each constituting T1, T2 and T3 groups.T1 group cattle were maintained on standard palleted concentrate (conventional feed available in market) feeding during morning and evening as per requirement with six hours grazing on *Cenchrus ciliaris* dominated pasture and water *ad libitum*. T2 and T3 group cattle were fed as per requirement with cheaper balanced concentrate mixture having 22% crude protein and 75% total digestible nutrient (TDN), however, in T3 group concentrate mixture was replaced by ground *Prosopis juliflora* pods to the extent of 30%. Concentrate mixtures of T2 and T3 group were iso-nitrogenous and iso-caloric. These lactating animals were provided with concentrate as per their maintenance and production requirement.

Experimental Lactating *Tharparkar* cattle fed on *P. juliflora* pod based Concentrate Mixture

Body weight

All the experimental animals were weighed in morning before feeding on day zero and there after at fortnightly interval however, result are presented on monthly basis. Daily examination for health of experimental cattle was done by veterinarian. The initial live body weights(kg) of T1,T2 and T3 group was 330.6 ± 15.32, 384.75 ± 29.51, 351.00 ± 13.77 and final were 315.58±10.96, 369.26±14.11, 344.0±30.51, respectively (**Table 2).** Most of the animals in all the three groups had parturition between November to March, however, they maintained their live body weights, which were comparable between the groups in given period of time.

Table 2. Body weight (kg) changes in lactating *Tharparkar* cattle fed on *P. juliflora* pod based concentrate mixture.

Cattle Group		May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
T-1	Avg.	330.6	321.00	323.35	310.605	305.155	325.045	319.43	324.67	345.86	317.51	315.58
	SE±	15.32	15.72	16.675	20.88	22.6	18.935	19.58	23.70	26.99	20.56	10.96
T-2	Avg.	384.75	371.89	375.25	365.73	359.815	389.04	392.20	368.33	370.72	366.17	369.26
	SE±	29.51	27.57	27.455	24.075	15.83	17.6	25.36	14.24	13.59	11.70	14.11
T-3	Avg..	351.00	348.16	363.525	362.925	359.1	384.05	370.67	378.33	398.63	382.8	344.00
	SE±	13.77	14.79	16.405	15.23	11.235	10.775	13.67	20.32	11.97	382.8	30.51

Fat and SNF parameter in milk

The fat and SNF% of milk of all the groups viz. T1, T2 and T3 showed no significant difference in quality as given in Table 3. These parameters varied with the stages of production and season in different groups.

Table 3. Fat and SNF % percentage of lactating *Tharparkar* cattle fed on *P. juliflora* pod based concentrate mixture

Cattle group		June		July		August		September		October		November		December		January		February		March	
		Fat (%)	SNF (%)	Fat (%)	SNF (%)	Fat (%)	SNF (%)	Fat (%)	SNF (%)	Fat (%)	SNF (%)	Fat (%)	SNF (%)	Fat (%)	SNF (%)	Fat (%)	SNF (%)	Fat (%)	SNF (%)	Fat (%)	SNF (%)
T-1	Avg.	3.42	8.38	3.62	8.43	3.89	8.51	3.57	8.21	4.02	8.20	0.39	8.43	3.80	8.40	4.16	9.01	3.56	8.76	3.05	8.36
	SE	0.17	0.06	0.23	0.09	0.22	0.13	0.32	0.18	0.29	0.10	0.39	0.16	0.84	0.12	0.55	0.19	0.45	0.13	0.37	0.11
T-2	Avg.	3.76	8.50	3.86	8.53	4.20	8.43	3.89	8.18	4.09	7.68	5.20	8.93	6.83	7.26	4.16	9.10	3.09	8.69	3.15	8.29
	SE	0.17	0.07	0.18	0.15	0.44	0.14	0.40	0.23	0.51	0.67	5.20	8.93	3.85	5.54	0.74	0.19	0.43	0.18	0.40	0.15
T-3	Avg.	3.81	8.53	3.50	8.33	3.92	8.47	4.04	8.28	4.32	8.40	4.38	8.63	3.88	8.21	3.69	8.88	3.83	8.87	3.34	8.47
	SE	0.13	0.11	0.23	0.07	0.26	0.10	0.35	0.24	0.33	0.15	0.28	0.14	0.46	0.13	0.21	0.16	0.12	0.08	0.23	0.14

Blood Parameters

During the feeding experiment blood samples were collected at monthly intervals from all experimented animal in the morning before offering feed from neck region through jugular vein puncture. Immediately blood was taken to laboratory for hematological i.e. haemoglobin (g%) and then plasma was separated for biochemical parameters viz., glucose, total protein, albumin, blood urea nitrogen, cholesterol, creatinine, calcium and inorganic phosphorus. All these blood parameters were in normal range and showed non-significant difference among T1, T2 and T3 groups (**Table 4 to12**). The result of the blood study showed that animals had normal body function with no change in blood chemistry when fed on *P. juliflora* pod based concentrate mixture.

Table 4. Haemoglobin (g%) status of lactating *Tharparkar* cattle fed on *P. juliflora* pod based concentrate mixture

Cattle group		Haemoglobin g %										
		May	June	July	Aug.	Sep	Oct	Nov	Dec	Jan	Feb	Mar
T-1	Avg.	10.76	11.01	9.93	9.90	8.93	9.16	9.03	9.20	9.74	9.6	9.52
	SE±	0.35	0.27	0.18	0.16	0.43	0.15	0.12	0.10	0.08	0.21	0.11
T-2	Avg.	10.85	11.15	10.2	9.9	9.62	9.2	8.96	8.85	9.73	9.2	9.5
	SE±	0.29	0.18	10.2	9.8	0.18	0.14	0.25	0.22	0.07	0.31	0.13
T-3	Avg.	11.63	11.67	10	9.7	9.23	9.40	9.00	9.00	10.07	10.2	9.7
	SE±	0.29	0.18	10	9.5	0.05	0.27	0.12	0.00	0.18	0.80	0.13

Table 5. Glucose (mg/100ml) status of lactating Tharparkar cattle fed on *P. juliflora* pod based concentrate mixture

Cattle group		Glucose (mg/100ml)										
		May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
T-1	Avg.	48.01	51.48	67.0	87.90	234.17	93.43	111.82	54.40	46.98	39.61	39.68
	SE±	1.76	1.62	1.84	1.60	22.86	7.97	1.41	2.99	3.99	2.65	2.52
T-2	Avg.	44.91	86.62	90.23	95.56	156.67	87.77	111.75	59.34	61.185	42.42	39.60
	SE±	1.50	0.84	89.12	90.5	33.06	10.06	1.73	1.62	2.71	3.20	6.96
T-3	Avg.	48.35	57.795	89.90	94.00	183.75	99.28	112.83	53.57	50.88	44.88	33.67
	SE±	0.46	0.43	0.56	0.45	22.58	9.09	1.82	4.19	12.65	11.93	4.81

Total 6. Total Protein (mg/100ml) status of lactating *Tharparkar* cattle fed on *P. juliflora* pod based concentrate mixture

Cattle group		Total Protein (mg/100ml)										
		May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
T-1	Avg.	10.55	7.09	8.46	7.75	6.89	10.32	9.82	9.34	23.95	8.63	20.65
	SE±	1.09	0.18	0.23	0.23	0.60	0.39	0.44	0.41	2.42	0.53	6.58
T-2	Avg.	10.14	7.24	7.86	7.90	8.29	11.87	10.36	11.20	28.89	8.84	9.74
	SE±	0.49	2.45	0.65	0.45	0.52	0.74	1.14	0.39	1.01	0.46	1.00
T-3	Avg.	10.22	6.94	8.00	7.38	7.64	11.33	10.29	10.02	27.90	8.76	44.22
	SE±	0.68	0.08	0.52	0.21	0.67	0.54	0.67	0.72	0.71	0.12	0.43

Table7. Albumin (mg/100ml) status of lactating *Tharparkar* cattle fed on *P. juliflora* pod based concentrate mixture

Cattle group		Albumin (mg/100ml)										
		May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
T-1	Avg.	3.26	3.46	3.59	3.89	2.85	3.80	2.55	3.30	4.40	3.95	4.2
	SE±	0.05	0.05	0.13	0.19	0.04	0.18	0.10	0.07	0.11	0.10	0.14
T-2	Avg.	3.32	3.52	3.66	3.78	3.04	3.70	2.87	3.35	4.46	3.88	4.41
	SE±	0.12	0.07	0.08	0.02	0.10	0.08	0.05	0.10	0.17	0.18	0.13
T-3	Avg.	3.26	3.47	3.84	387	3.02	3.57	2.65	3.12	4.24	3.53	4.50
	SE±	0.06	0.05	0.08	0.60	0.15	0.13	0.01	0.10	0.16	0.17	0.04

Table 8 . Blood Urea Nitrogen (mg/100ml) status of lactating *Tharparkar* cattle fed on on *P. juliflora* pod based concentrate mixture

Cattle Group		Blood Urea Nitrogen (mg/100ml)										
		May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
T-1	Avg.	37.17	38.55	44.41	55.89	65.38	54.57	72.11	53.82	23.31	57.72	29.78
	SE±	1.87	1.08	2.21	3.30	5.16	2.24	10.35	2.09	1.62	9.08	4.03
T-2	Avg.	33.12	37.3	32.97	44.90	59.40	48.71	61.91	37.06	20.53	43.26	27.75
	SE±	0.95	1.86	3.36	8.23	6.97	4.44	6.46	8.03	2.57	8.43	4.10
T-3	Avg.	36.50	40.34	49.53	62.89	77.70	47.33	74.98	49.98	26.12	46.63	34.95
	SE±	0.92	1.14	4.00	3.89	9.69	4.86	6.75	8.07	1.90	8.3	0.73

Table 9. Cholesterol (mg %) status of lactating *Tharparkar* cattle fed on on on *P. juliflora* pod based concentrate mixture

Cattle group		Cholesterol (mg %)										
		May	June	July	Aug.	Sep	Oct	Nov	Dec	Jan	Feb	Mar
T-1	Avg.	206.22	205.83	221.9	178.05	148.8	206.8	225.7	268.8	285.1	147.34	268.62
	SE±	9.00	16.80	16.23	10.34	25.65	2.04	59.92	29.84	44.49	38.31	57.78
T-2	Avg.	212.18	164.70	177.94	196.45	103.33	201.91	164.85	282.50	168.75	165.22	258.91
	SE±	26.96	45.66	51.71	25.98	6.75	1.45	14.83	53.31	25.78	39.17	46.50
T-3	Avg.	261.37	257.74	216.33	190.21	178.50	208.06	237.12	284.50	255.35	282.61	189.60
	SE±	12.33	14.11	26.23	45.35	23.68	2.09	31.18	56.84	36.79		332.54

Table 10. Creatinine (mg/100ml) status of lactating *Tharparkar* cattle fed on *P. juliflora* pod based concentrate mixture

Cattle group		Creatinine(mg/100ml)										
		May		June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
T-1	Avg.	1.74	1.81	1.89	1.93	1.98	2.06	2.10	1.56	1.34	1.64	4.26
	SE±	0.13	0.03	0.01	0.02	0.11	0.003	0.074	0.030	0.07	0.16	0.13
T-2	Avg.	1.90	1.90	1.97	1.98	1.72	2.06	2.25	1.54	1.14	1.7	4.61
	SE±	0.16	0.03	1.00	0.08	0.07	0.01	0.08	0.08	0.03	0.13	0.87
T-3	Avg.	1.93	2.02	2.0	1.98	2.03	2.06	2.25	1.69	1.43	2.13	4.89
	SE±	0.155	0.057	0.03	0.04	0.15	0.005	0.262	0.19	0.14	0.17	0.47

Table 11. Calcium (mg/100ml) status of lactating Tharparkar cattle fed on on *P. juliflora* pod based concentrate mixture

Cattle group		Calcium (mg/100ml)										
		May	June	July	August	Sep	Oct	Nov	Dec	Jan	Feb	Mar
T-1	Avg.	9.66	9.68	9.65	10.08	6.29	10.38	10.60	8.99	9.92	13.96	10.20
	SE	0.29	0.14	0.35	0.21	0.79	2.47	0.37	1.03	0.23	1.56	0.88
T-2	Avg.	9.75	9.46	9.89	10.53	8.04	11.53	10.48	6.32	6.60	7.27	13.23
	SE±	19.49	0.11	0.14	0.36	2.66	2.39	0.14	1.21	1.00	1.24	3.36
T-3	Avg.	9.18	9.91	9.99	10.28	7.82	34.43	10.94	7.50	7.56	8.11	13.33
	SE±	0.96	0.34	0.22	0.26	3.12	6.09	0.79	1.73	1.23	1.34	0.60

Table 12. Inorganic Phosphorus (mg/100ml) status of lactating *Tharparkar* cattle fed on on *P. juliflora* pod based concentrate mixture

Cattle group		Inorganic Phosphorus (mg/100ml)									
		May	June	July	August	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
T-1	Avg.	4.93	6.97	6.98	6.43	6.10	6.65	7.38	7.84	5.56	2.85
	SE±	0.03	0.14	0.13	0.18	0.23	0.31	0.73	0.49	0.38	0.24
T-2	Avg.	5.12	6.97	6.93	6.33	6.57	6.84	7.30	7.10	4.65	2.73
	SE±	0.07	0.34	0.30	0.31	2.45	0.19	0.46	0.94	0.29	0.28
T-3	Avg.	5.53	6.85	6.84	6.07	6.93	5.89	7.00	7.92	5.28	2.25
	SE±	0.60	0.66	0.58	0.54	0.11	0.47	0.17	0.66	0.38	0.40

Production and Reproduction Status

The average milk yield of T1, T2 and T3 groups for 305 days was 1858.9±209.2, 1885.0± 204.1 and, 2316.8 ±202.6 lit., respectively. Average total milk yield of T1, T2 and T3 groups was 1892.6 ± 236.5; 1942.7 ±204.9 and 2461.2 ± 197.7 lit., respectively (Table 13). All the three groups of animals viz. T1, T2, and T3 during experiment got conceived and parturated normally. Expulsions of placenta after parturition in all the three groups of animals ranged between 3 to 6. The calving Interval (CI) of these three groups i.e., T1, T2 and T3 animals prior to experimentation (preceding calving) had non-significant differences (Table 14) During the experiment calving Interval of animals of T1 and T2 had non-significant difference, and had less interval than the T3 group. The animals of T1 and T2 groups had significant differences with T3 group, which fed on with *Prosopis juliflora* mixed concentrate mixture.

Table13. Milk yield (ltr.) of lactating *Tharparkar* cattle fed on *P. juliflora* pod based concentrate mixture

305 Days Milk yield					
T1		T2		T3	
Cattle No	Milk Yield	Cattle No	Milk Yield	Cattle No	Milk Yield
111	1422.0	161	2448.1	172	2914.7
131	1618.1	176	1766.8	175	2084.7
142	2350.7	177	1492.3	230	2048.5
198	2044.8	227	1833.0	233	2219.4
Sum	7435.6	Sum	7540.2	Sum	9267.3
Avg.	1858.9	Avg.	1885.0	Avg.	2316.8
SD±	418.4	SD±	403.3	SD±	405.3
SE±	209.2	SE±	204.1	SE±	202.6
Total Milk yield					
T1		T2		T3	
Cattle No	Milk Yield	Cattle No	Milk Yield	Cattle No	Milk Yield
111	1422	161	2448.1	172	3005.5
131	1618.1	176	1766.8	175	2084.7
142	2485.7	177	1492.3	230	2284.5
198	2044.8	227	2063.6	233	2470.3
Sum	7570.6	Sum	7770.8	Sum	9845.0
Avg.	1892.6	Avg.	1942.7	Avg.	2461.2
SD±	473.2	SD±	409.8	SD±	395.5
SE±	236.5	SE±	204.9	SE±	197.7

Table 14. Calving Interval (CI in days) Pre and during experimentation of lactating Tharparkar cattle fed on *P. juliflora* pod based concentrate mixture

CALVING INTERVAL					
Pre -Experiment					
T1		T2		T3	
Animal no	CI	Animal no	CI	Animal no CI	
Average	398	Average	390.67	Average	390
SE±	23.88	SE±	11.39	SE±	5
During Experiment					
T1		T2		T3	
Animal no	CI	Animal no	CI	Animal no	CI
Average	376.5	Average	378.5	Average	447
SE±	16.63	SE±	11.51	SE±	23.49

The experimental results confirmed milk yield of cattle fed on *Prosopis juliflora* pods containing concentrate mixture increased significantly however, the calving interval of this group was also extended. The results indicated that *P. juliflora* pod based concentrate mixture had no adverse effect on health, reproduction and production of lactating *Tharparker* cattle.

Impact: *The product has been commercialized and being marketed brand name Kajri Pashu Aahar and Amrit Pashu Aahar.*

B. Feeding of concentrate mixture having non-grinded (as such) dried *Prosopis juliflora* pods on the performance of arid region goats

Prosopis juliflora tree provides dry pods which are valuable low cost fodder in the arid and semi-arid areas of Rajasthan, where it partly offsets fodder scarcity during dry season. Livestock browse these pods during grazing or are fed in the form of concentrate. The reports available indicated that feeding of *P. juliflora* pods without grinding causes health affection related with mastication, paralysis of jaw, etc. in the animals.

A feeding trial was undertaken to assess the performance of arid region goats fed on concentrates having different forms of dried pods. Eighteen growing goats (*Marwari and Parbatsari*) were divided into three groups, having six in each group based on their body weight and genetic make- up. All the animals were de-wormed against internal parasites and vaccinated against ET and PPR prior to the initiation of the experiment. The roughage was offered *ad libitum* in weighed quantity, which was similar to all the animals of three groups. However, the concentrate mixture was standard for the goats of control group (T_0), whereas, 50% dried ground *P. juliflora* pods in T_1 and 50% as such (non-grinded) dried *P. juliflora* pods in T_2 were included by replacing the standard concentrate mixture, however, all the three groups were given iso-nitrogenous and calorific ration. The concentrate mixture for T_1 and T_2 animals was prepared with wheat bran, tumba seed cake, guar korma, urea, mineral mixture and salt. In addition, water was made available *ad libitum* to all the animals. The observations were recorded for a period of seven months.

Experimental goats

P. juliflora seeds passed out in feces

Body weight changes in experimental goats are presented in Figure 1. The average body weight gain of these animals was 11.7, 9.7 and 9.7 kg in T_0, T_1 and T_2, respectively. Average daily dry matter intake (DMI)/100 kg body weight was 4.53, 4.68 and 4.79 kg in T_0, T_1 and T_2 groups, respectively. The animals in all the three groups lost their body condition and the average change in Body Condition Score (5 point score) was -0.17, -0.25 and -0.50 unit in T_0, T_1 and T_2, respectively (Figure 2). Average daily water intake per animal in T_0, T_1 and T_2 was 2.27, 2.34 and 2.29 lit. per day, respectively. The goats in all the groups exhibited normal heat signs in the breeding season. Five goats from each group were bred which became pregnant and delivered kids normally. The dystocia in a goat in T_2 occurred due to lateral deviation of neck of faetus however, faetus did not survive. The number of seeds per kg of feces voided in goats of T_2 was 136. None of the animals among all the groups was found suffering from any problem related with chewing the cud and facial muscle during the course of experiment.

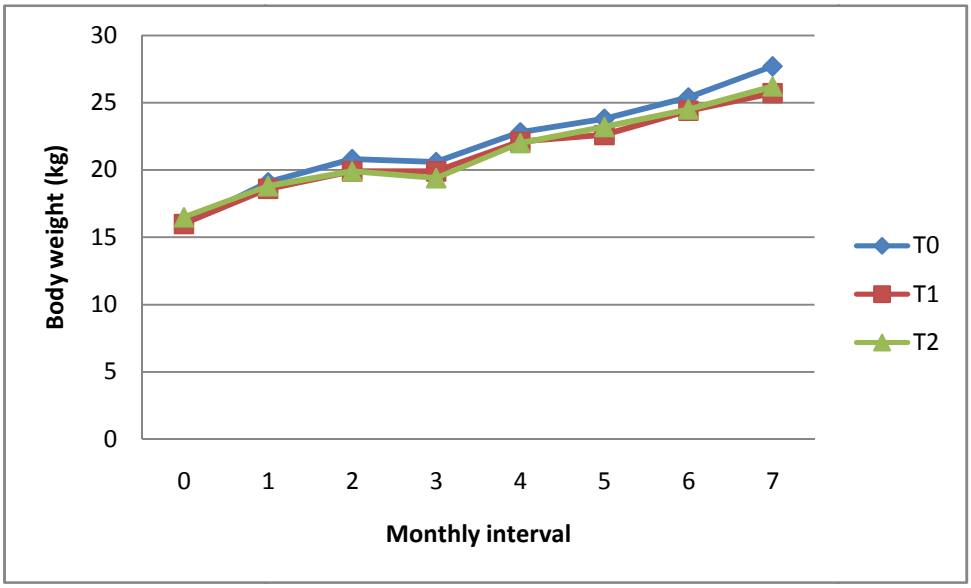

Fig 1: Body weight changes in experimental goats

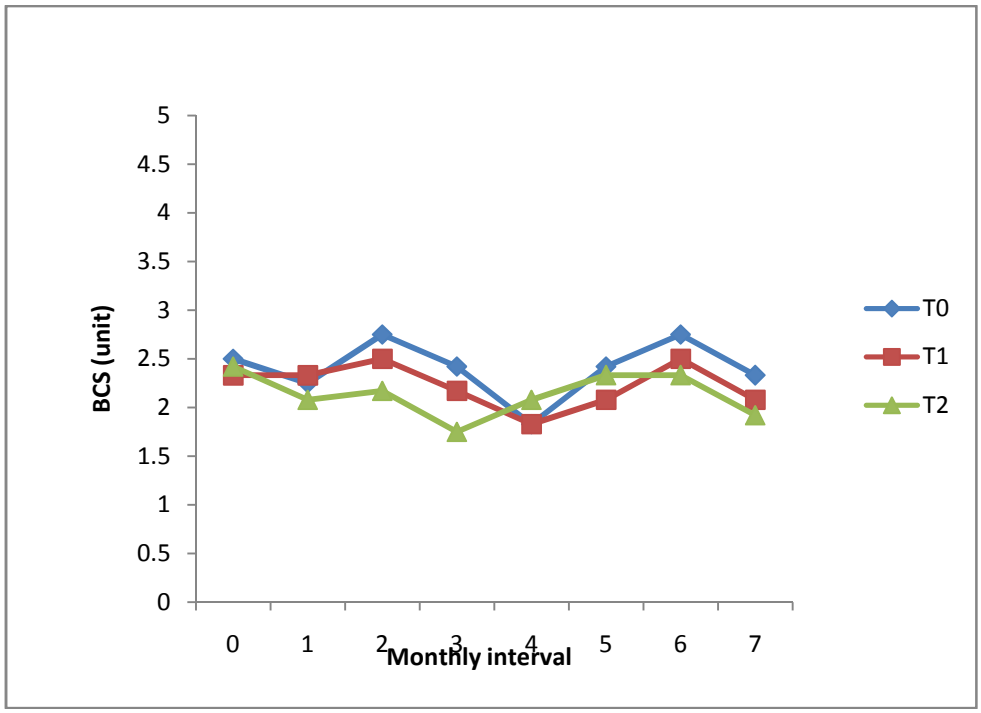

Fig 2: Body condition score in experimental goats

Impact: *Crushed whole pods of P. juliflora are not harmful at all. They create problem in the jaws of livestock only when eaten raw.*

C. *Prosopis juliflora* pod based multi-nutrient feed block

Guar seed meal is commonly used in multi-nutrient blocks. *P. juliflora* seed meal contained 2.77% minerals, 8.35% ether extracts, 44.00% crude protein and 44.90% total carbohydrates. These values are comparable with seed meal of guar. Therefore, in multi-nutrient feed blocks guar meal was replaced by *P. juliflora* seed meal. Moreover, mesocarp fraction of *P. juliflora* pods contained crude protein in similar quantity as that in case of wheat bran and carbohydrate content was appreciably higher than wheat bran. Owing to these qualities of *P. juliflora* pod mesocarp, wheat bran was replaced by it. This reduced the cost of conventional multi-nutrient feed block in one hand and added to its nutritive value on the other.

Three milled products viz., fibrous epicarp (A), fibrous endocarp (B) and amorphous mesocarp (C) of *P. juliflora* pods were used for production of multi-nutrient blocks (b), Ab, Bb and Cb. Physical characteristics and chemical composition of A, B and C were evaluated. On an average A, B and C on fresh weigh basis, contained 6.9, 7.1 and 8.1% preformed water, respectively, and on dry matter basis contained 95.3, 95.8 and 94.0% organic matter, respectively. Minerals present in A, B and C were in order of 4.7, 4.2 and 6.0%, respectively, crude protein 7.37, 10.70 and 12.76%, respectively and ether extractive 3.92, 4.24 and 9.16%, respectively. Total carbohydrates in A, B and C were 84.41, 80.86 and

72.05% respectively, and gross energy was in the tune of 425 k cal, 436 k cal and 467 k cal per 100 g, respectively.

The standard formulation *P. juliflora* pods based multi nutrient blocks Ab, Bb and Cb comprised of 44.5% , molasses; 4.31% urea dissolved in 4.0% water; 4.3% each common salt; vitamin-mineral mixture; and dolomite 32.10% wheat bran, 5.10% guar meal and 1.0% guar meal dust, which was used as a binder. All these ingredients were thoroughly mixed, pressed in screw type block making machine and dried in the solar dryer.

Chemical composition (% on DM basis) and physical characteristics of Multi-nutrient blocks prepared from various *Prosopis juliflora* pod milled products are given in Table 15.

Table 15. Chemical and physical characteristics of Multi-nutrient feed blocks prepared from various *Prosopis juliflora* pod milled products

	***P. juliflora* pod based feed block type**		
Chemical Attributes	**Ab**	**Bb**	**Cb**
Moisture* (%)	3.0	2.7	4.0
Ash (%)	17.4	17.2	15.9
Organic matter (%)	82.6	82.8	84.1
Crude protein (%)	20.7	22.2	20.9
Ether extractives (%)	7.0	6.04	6.0
Total Carbohydrates (%)	54.8	54.6	57.2
Gross energy (kcal/100g)	411	409	412
Physical characteristics			
Fresh weight, (kg)	2.40	2.40	3.40
Final weight (kg)	2.22	2.10	3.23
Loss on drying (%)	12.7	12.4	5.0
Volume (Cu cm)	2457	2071	2792
Bulk density (g/Cu cm)	0.9	1.02	1.16
*As such basis.			

The data indicated that the *P. juliflora* pod based feed can be used for production of multi-nutrient feed-blocks for supplementation of essential nutrients to desert livestock.

Impact: *Feed and water intake of cattle was increased, which ultimately improved the livestock health and production.*

D. *Prosopis juliflora* pod based feed block

Technology for production of *P. juliflora* pod based feed block was perfected. This block contains 73.5% whole pod powder including crushed seeds and other ingredients. The chemically this block contains pre formed water 8.1% minerals 9.9%, Organic matter 92.4%, crud protein 20.3%, either extract 2.0%, total carbohydrates 67.9% and gross energy 415 kcl/ 100 g.

***Prosopis juliflora* pod based feed block**

Feeding of *Prosopis juliflora* pod based feed block to cattle: *A field trial*

Prosopis juliflora pods are palatable feeds and good sources of energy for ruminants due to their digestible carbohydrate content. They can replace costly part of the diet grains to make the concentrate feed cheaper. Supplemented *P. juliflora* feed blocks were prepared with dried *P. juliflora* pods (73.5%), molasses (4.9%), urea (2%), dolomite (1.5%), guar korma (8.2%), tumba seed cake (6.9%), vitamin added mineral mixture (1.5%) and salt (1.5%). These ingredients were mixed in feed mixture and blocks (2 kg each) were prepared with fodder block making machine. The field trial was started on ten lactating indigenous and crossbred cows selected from villages of Nagaur district for a period of three months. One kilogram of the block was offered to each cow daily. The observations on daily milk yield and monthly length and girth parameters of experimental cattle were recorded.

A cow feeding on *P. juliflora* feed blocks

P. iuliflora feed blocks

The milk yield persistency of the cows fed with supplemented *P. juliflora* feed blocks has been shown in Fig 3. Average initial and final milk yield per cow per day was 4.55 and 5.53 lit., respectively. Persistency of milk yield was maintained for the entire period of field trial. The body measurements of the animals did not show any significant change in the body

weight of animals. Average initial and final body weight of the cows were 337 and 342 kg, respectively. These animals did not show any health problem after consuming these blocks.

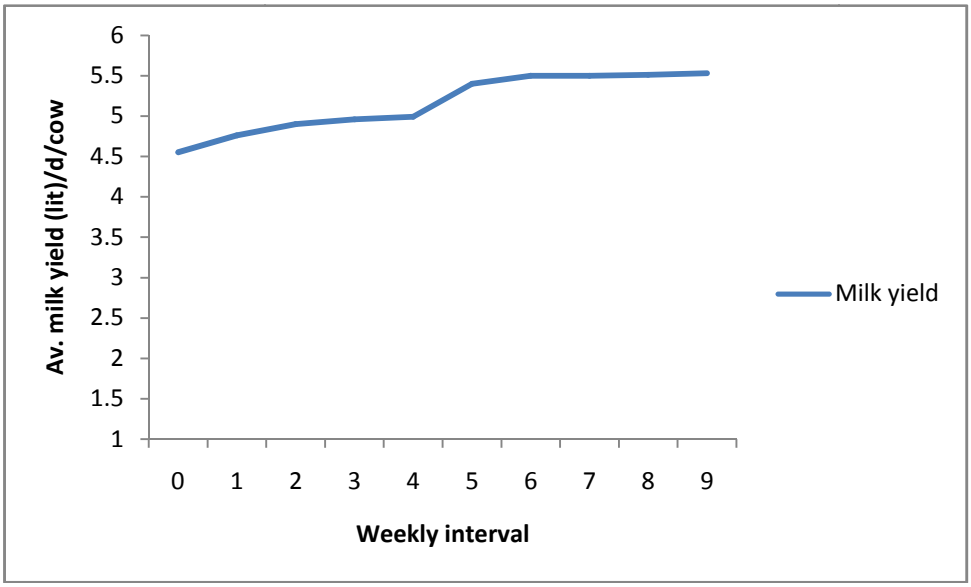

Fig. 3. Persistency of milk yield in cattle fed with supplemented *P. juliflora* feed blocks

Effect of feeding of *Prosopis juliflora* pod based feed blocks on performance of Goats

Prosopis juliflora pods are a potent feed resource for arid regions' livestock. These are highly palatable and nutritious. Diet containing 20% pods improved feed intake, feed conversion efficiency and body weight gain without compromising carcass yield or quality in goats. The experiment was conducted to assess the effects of replacement of wheat bran with dry pods of *P. juliflora* on feed intake, growth and hemato-biochemical constituents in growing goats.

Twenty-four growing *Marwari* and *Parbatsari* goats of similar age (6 months) were divided into four groups of 6 animals in each group i. e. Group C_1 (6 males):control; group C_2 (6 females):control; group T_1 (6 males):treatment and group T_2 (6 females):treatment. The animals of control (male & female) and treatment (male & female) group were offered weighed quantity of complete fodder block consisting 70% lentil straw and 30% concentrate *ad libitum* however, in treatment groups, 30% wheat bran of concentrate was replaced by *P. juliflora* pod powder. In addition, water was made available *ad libitum* to all the animals. The observations on dry matter intake, water intake and body weight changes were recorded at fortnight interval up to three months of study period (April-June). Blood samples were taken in anticoagulant coated vials aseptically from jugular vein.

P. juliflora pod based feed block

Experimental goats

The performance parameters of the growing goats are given in Table 16. Highest intake of DM (kg/100kg body weight) was in C_2 goatlings, whereas, lowest in T_1 bucklings. Average DM intake /100 kg body weight by the animals of control and treatment group was 4.46±0.23 and 4.01±0.14 kg, respectively. DM intake values did not differ significantly between the groups.

Table 16: Mean values of performance traits and hemato-biochemicals of experimental goats

Particular		C1	C2	T1	T2
Performance traits					
Dry matter intake/day (kg/100 kg body weight)		4.12±0.43	4.83±0.11	3.75±0.18	4.27±0.16
Water intake/day (lit./100 kg body weight)		12.6±1.02	15.7±1.04	11.9±0.69	13.8±0.61
Average daily gain (g/day)		52.89±14.68	46.44±3.62	59.56±5.36	55.56±6.46
Feed conversion ratio		14.94	14.21	12.09	10.98
Hemato-biochemicals					
Haemoglobin (g/dl)	Initial	8.95±0.54	8.55±0.90^{b}	8.80±0.29^{b}	9.65±0.52^{b}
	Final	10.45±0.78	11.90±0.06^{a}	11.10±0.21^{a}	11.25±0.29^{a}
Total Protein(g/dl)	Initial	5.64±0.19	5.74±0.25	5.60±0.16^{b}	5.95±0.23
	Final	6.42±0.13	6.49±0.18	6.46±0.27^{a}	6.20±0.39
Blood Urea N_2(mg/dl)	Initial	15.61±1.23	11.80±0.69	14.23±1.27	16.53±1.04
	Final	15.50±1.58	17.65±0.22	17.25±1.69	16.25±1.10

The means with different superscripts within a column differ significantly (P<0.05).
C_1: Control-male; C_2: Control-female; T_1: Treatment-male; T_2: Treatment-female

The T_1 group had the highest average total weight gain 5.36 kg followed by T_2, C_1 and C_2 with 5.0, 4.76 and 4.18 kg, respectively (Fig.4.). Overall both the treatment groups exhibited higher average daily gains (ADG) than the control groups. All the animals gained higher body weight in second half of the experiment period than that of first half and the buckling of T_1 gained highest in the second half. In terms of feed conversion ratio (FCR), T_2

group was the best with a 10.98 ratio however; C_1 was the poorest with 14.94 ratio. Average water intake per animal/day did not differ significantly between the groups.

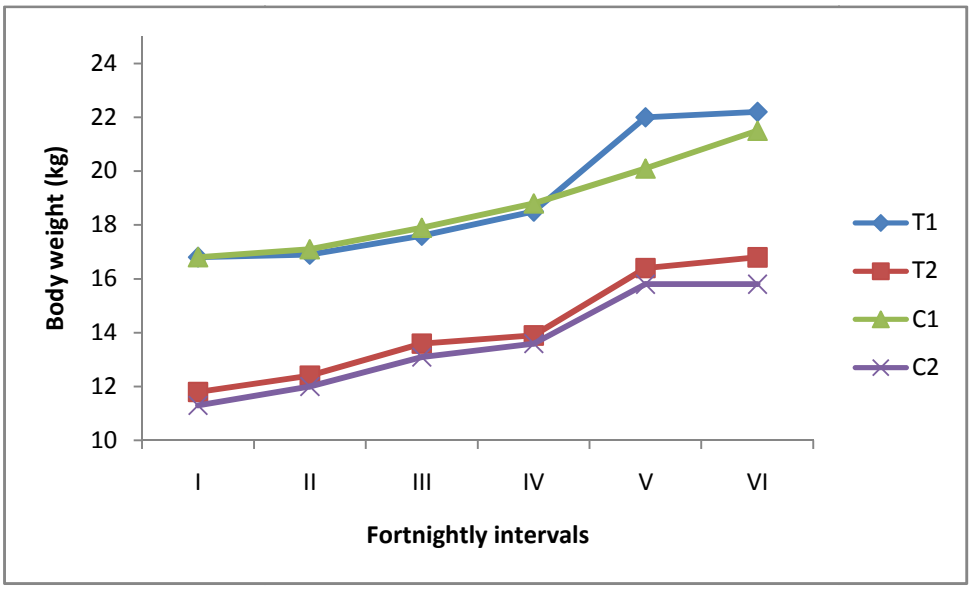

Fig. 4. Growth performance of experimental goats

The values of hemoglobin, total protein and blood urea nitrogen were within the physiological limits. None of the animals in the present experiment were found suffering from any problem related with chewing the cud and facial muscle. Results indicated that *Prosopis juliflora* pods can safely be used in place of wheat bran up to 30% in concentrate feed to improve body weight gain of growing goats without compromising health status.

Impact: *Feed blocks based on P. juliflora pod flour are very useful for livestock feeding in lean fodder availability periods because its high nutritive value and maintaining persistency in milk yield and health. The adoption rates of these blocks are quite appreciable.*

- **Development and refinement of human food products prepared by *Prosopis* pods having high and low sugar content and their physico-chemical analysis.**

In its native range viz. Peru, Brazil, Argentina and other Latin American countries lot of products processed using *P. juliflora* pods and pods of other *Prosopis* species for human consumption. However, due to lack of awareness millions of tones of *P. juliflora* pods always go waste every year in hot arid and semi- arid regions of India. In the present NAIP sub-project attempts were made to process some value added products for human consumption using pods of this species.

The plant is locally known as Angrezi Babool /Vilati Bawaliya in Rajasthan; Ganda Bawal in Gujarat; Vilati Kikar in Haryana and Karuvali / Velikaruvi in Tamil Nadu. The species produce pods from December to May. Once introduced in Rajasthan as a "Royal tree" in early 1930s, today it is considered disaster in many quarters. According to available reports, the plant is first introduce in Indian sub- continent about 144 years ago. When plant was introduced, the seeds lots came from Mexico, Peru and Argentina and they were highly mixed. In addition to *P. juliflora,* many other *Prosopis* species seeds were mixed in these seed lots. So many sweet pods species trees spread in scattered manner in hot arid and semi

arid parts of the country. The sweet pod species available in CAZRI, Jodhpur were used to process some products for human consumption using pod flour of such species.

A. Human consumption products developed by using pod flour (mesocarp fraction) of sweet pod bearing *Prosopis* plant types

***Cussar* powder:** *Cussar* powder is prepared commonly in households of *Hindu* community throughout the north India for offering to Gods and Goddesses as an introductory products during the course of different types of prayer and *poojas*. Using pod powder of sweet pod bearing plant type, *cussar* powder was processed using following process.

Semolina + Pod powder of sweet pod baring *Prosopis* plan type

Roasted in hydrogenated fat ⇩

Add powdered sugar

Mix ⇩

***Cussar* powder**

Doughnuts: Doughnuts are prepared as snacks throughout the country. Using pods of sweet pod bearing *Prosopis* plant types doughnuts were prepared using the process mentioned as under.

Refined wheat flour 75% + Pod powder of sweet pod baring *Prosopis* plan type 25%

⇩

Sugar, Baking powder made into dough with

Essence and Egg

⇩

Extruded into shapes

⇩

Deep fried in oil

⇩

Doughnuts

Biscuits: In Latin American countries pod powder of sweet pod bearing plant type of species is used in a large scale in confectionary items. Pod powder of sweet pod bearing *Prosopis* plant type acted as a leavening agent and it incorporated air in the product which resulted in its puffing. This property as a leavening agent of pod powder of sweet pod bearing *Prosopis* plant type can be used in large scale in confectionary items. The biscuits were prepared by following process:

Refined wheat flour 75% + Pod powder of sweet pod baring *Prosopis* plan type 25%

⇩

Sugar, Baking powder made into dough with Essence and Egg

⇩

Extruded into shapes

⇩

Baked at professional bakery

⇩

Biscuits

***Laddoo*:** The *laddoos* are very common sweet preparation of India. *Laddoos* were prepared using Pod powder of sweet pod baring *Prosopis* plan type by using following procedure.

Pod powder of sweet pod baring *Prosopis* plan type 200 g + 200 g Bengal g flour

Roasted in hydrogenated fat ⇩

Add sugar syrup (200 g)

⇩ Rolled into round shapes

Laddoos

The organoleptic evaluation of above preparations was done at 9 point hedonic scale. The results of which are given in Table 16. Among the products developed the overall acceptability was highest for the biscuits prepared by using pod powder of sweet pod baring *Prosopis* plant type. The acceptability of *cussar* powder was also very good. As availability of sweet pod bearing plant types of *Prosopis* is very meager, therefore plantation of such plant types have been done under the present project so that in future pods of sweet pod baring *Prosopis* plant type could be available in large scale to process the value added products for human consumption.

Table17. Results of organoleptic evaluation of products for human consumption derived from using Pod powder of sweet pod baring *Prosopis* plant type

Product	*Colour*	*Flavour*	Taste	After taste	Overall acceptability
Cussar *powder*	5	6	5	**5**	5
Doughnuts	7	5	7	**5**	6
Biscuits	8	7	8	**6**	7
Laddoo	6	4	5	**5**	5

Impact: *Pods of sweet pod bearing plant types of Prosopis can be used for various preparation at household level.*

B. Value added products derived from abundantly available *Prosopis juliflora* pods

Coffee substitute

The prepared coffee contained 70% *P. juliflora* pod powder 20%, raw coffee powder and 10% chicory powder. *Prosopis juliflora* pod powder was roasted for six hrs in 150 ^{0}C which resulted in 93% roasted material. Roasted material was sieved and byproduct (73.3%) was separated. remaining 21.4% was put in a preheated oven (250^{0}C) for 3 hrs, resulting in a product having more or less similar smell and taste that of conventional instant coffee. To enhance the value of the product Chicory powder and raw coffee powder was mixed. However, before selecting the best combination of various ingredient organoleptic evaluation was done at 9 point hedonic scale. The results are given in Table 18. The best combination which was liked by the people who participated in the organoleptic evaluation was 70% processed *P. juliflora* pod powder: 10% chicory powder: 20% raw coffee roasted powder.

Table 18. organoleptic evaluation of various ingredients in developed coffee substitute

PJPP : chicory(1): coffee(2)	Colour	Flavour	Taste	After taste	Overall acceptability
80:10:10	8	6	7	7	7
80:20(**1**)	7	6	6	4	6
80:20(**2**)	7	6	6	4	6
70:15:15	6	7	6	4	6
70:20:10	6	6	7	5	7
70:10:20	**8**	**7**	**8**	**4**	**9**
70:30(**1**)	7	6	5	5	6
70:30(**2**)	7	7	8	5	7

PJPP= *Prosopis juliflora* pod powder

Coffee prepared from different combinations of *P. juliflora* coffee: Chicory powder : Raw coffee

Shade card to match the précised point for roasting of *Prosopis* pod powder for preparation of coffee

The roasting of *P. juliflora* pod powder for making it into a coffee like powder require continuous management. This work requires skills. Therefore, to know the exact temperature point in which the roasted *P. juliflora* pod powder gives aroma and colour similar to that of conventional coffee, a shade card was developed for roasting of *P. juliflora* pod flour for preparation of *Prosopis* coffee. The initial coffee preparation was done by setting a temperature of 150^0 C for 6 hours in the oven. The process is modified by preheating the oven at 225^0 C for a maximum of 2 hours and then roasting *P. juliflora* powder. Based on the position of the trays in the oven, they achieved the end point any time between half an hours to two hours. The end point is used for developing the shade card. By this shade card one can easily roast *P. juliflora* powder precisely for coffee preparation.

Shade card developed to know the roasting stage in which *P. juliflora* pod powder gave exact aroma and colour like that of conventional coffee

Comparison of chemical attributes of raw coffee and *P. juliflora* pod based coffee

Analyzed *Prosopis* coffee for its chemical traits and compared them with normal raw coffee (Table 19). The data indicated that there is not much difference in different chemical traits of raw coffee and *P. juliflora* pod based coffee for which production technology has been perfected inpresent NAIP sub-project.

Table 19. Physico-chemical properties of Raw coffee and *P.juliflora* pod based coffee

Components%	Raw coffee (*Coffee robusta*)	*P.juliflora* coffe
Moisture	4.54	2.72
Ether extract	4.45	8.15
Crude protein	16.98	10.15
Total carbohydrates	60.92	75.45
Ash content	6.15	6.25
Gross energy (K cal/100gm)	445	447

Instant Juli Coffee

The process for preparing coffee was further refined and technology was perfected. This technology was passed to industrial partner **National food product Jodhpur India Ltd**. Ripe pods of *P. juliflora* were thrashed in a specially designed plot thresher and epicarp+ mesocarp and endocarp is separated. The epicarp + mesocarp mixture is sieved by very fine sieve. By threshing and sieving 20 kg pods, approximately 5kg fine mesocarp is obtained which is used for processing "Instant Juli Coffee". This fine mesocarp powder is roasted at specified temperature and time in a pre-heated oven with intermittent mixing. The powder thus obtained is matched with a shade card developed to determine end point. Roasted powder thus obtained is blended with specified amount of original roasted coffee powder. After mixing original roasted coffee powder, specified quantity of chicory powder is mixed in this mixture. Thus, the obtained mixture of *P. juliflora* roasted mesocarp powder, original coffee powder and chicory powder gives taste, colour and aroma of normal instant coffee.

For obtaining best and highly soluble "Instant Juli Coffee" the mixture obtained as above is dissolved in water and filtered. In this way "Instant Juli coffee" powder solution is obtained which is freeze dried. After completing this process best quality " Instant Juli coffee" is obtained. This instant "Instant Juli coffee" made in to desired marketing packing. The technique for processing of vacuumed freeze dried "Instant Juli Coffee" given below.

3000 g *Prosopis juliflora* pods milled

Fine sieving (by 20 mesh sieve)

(73.3% byproduct, 2200 g for animal feed)

800 g fine pod powder

Further sieved, 600 g *P. juliflora* pod powder obtained

250^0 C 3 hrs, with 150^0 C pre heating for 1hr

600 g *Prosopis* coffee powder

+

10% Chicory powder + 20% raw coffee powder

Vacuum Freeze Drying

(Some amount is lost during the process)

613 g ready to use coffee powder

Made into marketable packets (50g)

Pilot scale Juli coffee production by industrial partner and former ND, NAIP visiting industrial unit

Testing for food safety standard

Industrial partner has started pilot scale production and sending Instant Juli coffee to his agents throughout India to understand its acceptability. The acute toxicity test was conducted on rats and mice using whole pod and mesocarp.No pre terminal deaths were recorded in animals fed 1.6 and3.2 times higher dose. No significant difference in body weight was observed. No gross necropsy changes were observed in organs. The Sub-chronic safety evaluation conducted for 90 days revealed no mortality in any group of animals, Clinical chemistry and hematology profile indicated no abnormal changes in rat and mice fed with

mesocarp and whole pod feed @ of 40% and 80% in daily diet . The replacement of *Prosopis juliflora* mesocarp 40-80% with wheat or pearl millet also did not harm experimental rat and mice . All raw data, documentation, records ,specimens ,slides ,protocols generated in the study have been kept confidential, inventoried and archived in Archives room by Archiving officer at NIN (National Institute Of Nutrition), Hyderabad in main building for 6 years.

Impact: *A unique prized product has been developed and ready for commercialization such toxicity analysis of Prosopis juliflora pods was perhaps carried out first time in the world.*

***Prosopis juliflora* pod based syrup and fine flour**

Sound and ripe pods were selected, washed and broken into small pieces. Three hundred and fifty grams of pods were boiled in water (1 liter) for two hours followed by sieving to separate the coarse particles. About 100 ml liquid was obtained from 350g pods. To obtain the syrup, the liquid was boiled until it reached the necessary consistency. This thick liquid was yellowish brown in colour and can be used as a beverage directly or can be mixed with milk and fruit juices. This syrup is widely used in Latin and South American countries. The residue left after preparing the syrup was used for producing fine flour. The quantum of fine flour obtained from 350g pods was 62g. The fine flour obtained by this process was suitable for use in confectionary items. Juli Syrup and other different fraction obtained during ***Juli Syrup*** preparation had following nutritive attributes.

Table20. Chemical composition of Julii syrup, fine flour and fine fiber

Products	Ash*	Organic Matter*	Crude Protein*	Ether extractives *	Total Carbohydrates*	Gross energy, Kcal/100 g
Juli Syrup	9.25	90.70	12.82	8.00	69.93	438
Fine Flour	2.00	98.00	8.29	10.25	79.46	473
Fine Fiber	2.50	97.50	4.54	8.00	84.96	453

*On dry matter basis

Impact: *Food supplement can be processed at household level. Villagers in target sites have been trained and many of them are using Juli syrup in their diet. Fine flour is highly suitable as a leavening agent for confectionary items.*

- **Study of the present use of *Prosopis* pods and impact of various developed feed and food products on the economy of rural people and also pricing, marketing and social aspects of *Prosopis* products value chain.**

Great strides have been made recently in southern USA, Mexico, central and south American countries where *Prosopis juliflora* grows naturally, to improve the species using genetics and breeding to achieve a gain in important traits such as rate of diameter and height growth, length of straight bole and pod production. In India, because of its aggressive invasion of land, opposition to *P. juliflora* has come from various quarters including forest department of several states. However, other criticisms are harder to substantiate, they includes an

unconfirmed lowering water table and adverse affect on growth and yield of arable crops. However, one thing in certain that is a potential sever of rural people in hot arid and semi-arid regions. Poor farmers are very aware of its importance. It is beyond doubt that at the moment the species is a vast natural resource and must be utilized for the benefit of the rural folk of hot arid and semi -arid regions of the country. In the present NAIP sub-project, we worked in same direction and utilize the species for the development of value added products from its pods which are available abundantly.

A. Sample survey to study present use of *Prosopis juliflora*

Sample survey was conducted in village Lalpura and Sayara Dhani (Tehsil Sanchore), Gagipura, Khanpur, Golia, Kotra and Mandhara, village (Tehsil Bhinmal) of Jalore district, Rajasthan. *P.juliflora* is found on village CPRs, revenue lands, other waste lands and on the boundary of the farmers' fields.

Maximum number of household belonged to marginal and small farmers' class. The family size was generally large (> 7 members). In the entire project area, joint family system was prominent, however, a shift towards nuclear family is evident from the information collected during base line survey. The housing pattern at and around the project area exhibited dominance of mixed housing (i.e., household were having both *Kuchha* and *Pacca* structures). Interestingly, livestock rearing trend was quite different than other parts of arid zone, where cows are prominent wealth of the farmers. In the project site villages, in addition to cows, some buffalo population was also there. The trend clearly indicated the availability of more fodder and material for the concentrate. Sheep and goats were recorded in large numbers.

Farming is mixed crop - livestock based. Intensive labour operations are required during cropping season and therefore, next most important occupation was that of agricultural laboure. Intensive survey in the area revealed those maximum households were having family income between Rs. 3000 - 5000/- per month. Only 16% families belonged to higher income group i.e., having monthly income more than Rs. 10,000/-.

P. juliflora is used by almost all the household for firewood purpose. In fact, species is the only source of fuel for the farmers. However, farmers allow their livestock to graze on fallen pods of the species. Sometimes, they also collect the pods for stall feeding of the animals with other fodders. But they had no idea about the multipurpose use of the species. Even some times they complained regarding loss in their crop production due to the presence of the species on boundary of the farm fields. Many farmers are engaged in preparation of charcoal by using wood of the species, which is not an environment friendly enterprise.

The logs of the species were widely used in *Kachha* house, especially for roofing purpose. Thus, the species is indirectly benefited the farmers and on and average, across different income groups every year Rs.3500/- were being contributed by the species. The lack of awareness is the main factor, which was not allowing farmers to utilize the species up to its full potential. Survey clearly reveled that farmers in target area are completely un-aware regarding economic value of the species.

Impact: *Actual status of use of various parts of trees and thickets of P. juliflora in hot arid region and its role in rural economics documented.*

B. Popularization of various uses and processed *Prosopis* products through capacity building of all stakeholders

Establishment of pod collection and field training centre

Pod is a critical and sole important for developing the value chain of value added products of *Prosopis juliflora*. Continuous motivation of primary stakeholders through field trainings regarding collection and grading of *Prosopis* pods resulted in establishment of pod collection and field training centre by the efforts of villagers in Lalpura village, tehsil Sanchore, district Jalore.

Views of pod collection and training centre at village Lalpura

In this centre the pod collected by farmers' are purchased by a highly entrepreneur farmer in a pre- decided rate by farmer group of the village. A modified pod thresher was provided in the centre and farmers also thresh the pods. They are also paid for threshing the pods. The processing unit purchase raw pod @ Rs 5/kg and primary value added (PVA) pod @ Rs 6/kg. On an average every year from 2011, Amrit Agro Industry, Jodhpur, a very active voluntary partner of our consortium purchased raw pods and primary value added pods to the tune of 30-40 t from this centre. Thus, the centre earned Rs 247500 every year. This centre is also a place for imparting different kind of skill development trainings for primary stakeholders related to pod collection, grading, threshing and processing of *P. juliflora* pod based concentrate ration at their door steps. The contribution of this centre in present NAIP sub-project was immense.

Impact: *Skill and capacity development of farmers. Increased extra income and enhanced livelihood opportunity.*

Establishment of participatory farmers' nurseries

Two farmers' nurseries were established in target villages one at village Lalpura and another at Syara Dhani. In each nursery more than 10,000 seedlings of sweet pod bearing *Prosopis* plant types were raised during year 2011, 2012 and 2013. Farmers' sold these seedlings to our voluntary partner Trans-tech Green Powder Ltd. Chiltawana, Sanchor. At the rate of Rs. 5/ seedling. Thus, every year participating farmers' group of each village earned Rs. 50,0000 (Rs 1.00 lac from two nurseries). This activity has high potential for extra income generation source for primary stakeholders.

Nursery area identification

Layout

Poly bag filling

Seed sowing

Overview of nursery

Impact: *Increase household income, skill development, more participation of women folk and enhanced livelihood security.*

***Prosopis* species acceptance analysis**

A study was carried in target villages to understand the acceptance level of *P. juliflora* pod based livestock feed. *Amrit Pashu Aahar* processed and marketed by our voluntary partner Amrit Agro Industry, Jodhpur was supplied free of cost to 10 households each in four villages which were, not the part of target villages of the sub-project. The care was taken to select such households in which the number of lactating cows was three and more. NGO partner DECO, Jodhpur was responsible for this front line demonstration. The *P. juliflora* pod based feed was provided for 3 months to selected households. The farmers were given advice to use the feed for only one and same cow and take observation on some important health and milk yield issues. These villages were: Dotiana, Dheari and Harsolav in Nagaur district. At the end of three months simple information was collected from participating households in each villages regarding acceptability of *P. juliflora* livestock based feed. The results of the study are set in Table 21.

Table 21. Acceptability of *P. juliflora* pod based feed at primary stakeholder's level

Village	Particular	Conventional Feed	Amrit Pashu Aahar*	Farmers' Opinion (% acceptability of *P. juliflora* pod based feed)
Dotiana	Health Issues	No complaint	No complaint	80
	Feed Intake	Normal	Slightly better	70
	Water Intake	Normal	Slightly better	70
	Cost	High	Relatively lower	100
	Milk yield	Normal	High	100
Dheari	Health Issues	No complaint	No complaint	90
	Feed Intake	Normal	Normal	60
	Water Intake	Normal	High	70
	Cost	High	Relatively lower	100
	Milk yield	Normal	High	80
Harsolav	Health Issues	No complaint	No complaint	100
	Feed Intake	Normal	High	80
	Water Intake	Normal	High	80
	Cost	Normal	Relatively lower	100
	Milk yield	Normal	High	90

Amrit Pashu Aahar is P. juliflora pod based which is being marketed commercially.

P. juliflora pod based feed trials at selected village

In general, there was no complaint in any household on health issues of the animal as far as *P. juliflora* based feed is concerned. In village Dotiana and Dehri 20% and 10 % households respectively did not give any opinion. In village Dotiana and Harsolav more than 70% households reported higher feed and water intake by the cows who are given *P. juliflora* pod based feed. In Dotiana and Dheari villages all the households had opinion that milk yield was higher in case of cow which was given *P. juliflora* pod based feed, Only 10% households in Harsolav reported that there was no increase in milk yield. When asked about the cost of the conventional feed which participating household were purchasing from market in comparison to provided *P. juliflora* pod based feed, all households had the opinion that it is relatively much cheaper.

Impact: *Horizontals extension of P. juliflora pod based processed products and technologies.*

National Workshops

During the course of present NAIP sub-project, three mega National Workshops were organized. First workshop entitled **"*Prosopis juliflora*: Past, Present and Future"** was organized at CAZRI, Jodhpur from 23rd to 24th March, 2011. The workshop was inaugurated by Breg. Manjeet Mehta, SM , VSM and Commander Jodhpur sub-area on the morning of 23rd March, 2011. More than 100 delegates (scientist, researchers, academicians from universities, NGOs, persons from industries and farmers) from different parts of country and one foreign delegates **Mr. Simon Choge, Principal Research Scientist from Kenya participated in the workshop**. During the course of workshop in addition to research paper presentations, the delegates visited CAZRI pod processing facility and participating industrial unit. Overall the workshop was grand success and it was covered widely in print and electronic media.

The second National Workshop entitled " **Utilization of *Prosopis juliflora*: Challenges and Opportunities**" was organized on 12th and 13th March, 2012. The workshop was inaugurated by Dr. J. C. Dagar, ADG (Agroforestry and Agronomy), ICAR, New Delhi who was Chief Guest of the inaugural function. Again during this workshop surprisingly 130 delegates (scientist, researchers, academicians from universities, NGOs, persons from industries and farmers) took part from different parts of the country. Very meaningful discussions were held during the course of workshop. The discussion were centered around how to utilize *P. juliflora* pods, abundantly available in entire hot arid and semi-arid tracts of India.

Third National Workshop entitled "***Prosopis juliflora*: Retrospect and Prospects** "was organized at CAZRI, Regional Research Station, Kukma, Bhuj from 26th to 28th February, 2013. The workshop was inaugurated by Prof. Tushar Hathi, VC, Kuchh University, Bhuj. Mr. A. J. Sah, IAS, District Magistrate, Bhuj was guest of honour. The workshop was attended by more than 100 delegates (scientist, researchers, academicians from universities, NGOs, persons from industries and farmers) and the deliberations were centered on value chain of value added products developed in present NAIP sub-project. A field trip to Banni area was organized on 28th February, 2013. The print and electronic media covered the event widely.

Impact: *Wide publicity of Prosopis products, shared experience and knowledge available in different quarters*

Field days/ off and on-campus trainings and group discussions

Organization of Field days, off and on-campus trainings and group discussions are effective means for skill development and capacity building of farmers', the primary stakeholders for achieving the goals of the sub-project. During the course of present NAIP sub-project 15 field days, 11 on and off-campus trainings and 6 group discussions were organized at target villages sits and other potential sites.


Field Days


On-campus trainings


Off- campus trainings


Group discussions

Impact: *Adoption of technologies, capacity building of primary stakeholders for processing P. juliflora pod based cheaper concentrate mixture at household level, additional employment generation*

6. Innovations

A. Public- private participatory model for up-lifting rural economy

Transtech Green Power Limited, established a electricity generation plant at Chitlawana, Sanchore, district, Jalore (near to our target villages at Sanchore). The plant is a small scale unit, which is generating electricity using biomass. The concept was to generate electricity by using crop residue. However, when plant was commissioned and started generating electricity, it was found that crop residue available is sufficient for only three months. The unit was shut down for some time and then they stated importing woods scarp as far as from U.P., Punjab and Haryana because only small chips are required to heat the boiler. Cutting of *P. juliflora* stems is not prohibited, we suggested them to ask villagers to cut the side stems from *P.juliflora* thickets and leave 2 or 3 central stems of good diameter (5.0-6.0 cm) **(see annex 1).**

View of electricity generation plant, stems transportation and chipping of stems in the plant

A delegation from Kenya visited to study our *P. juliflora* value chain

On our advice Transtech Green Power Limited provided diesel driven power saws to our groups of farmers. The farmers of our target villages started supplying *P. juliflora* wood to power plant. The availability of huge amount of *P. juliflora* wood has become a boon for the plant and it started generating 10 MW electricity 24 hrs/ day year round. On the other hand farmers received good amount of money by the sale of *P. juliflora* stems. We build the capacity of the farmers through On-campus trainings on *P. juliflora* management and following our advice they always left 2-3 central stems of 5.0-6.0 cm diameter. In the process those stems grew straight and plants started assuming tree shape. Tree shape plants bear very

good amount of pods. Thus, this has been a win- win situation for all partners. A delegation of forestry expert from Kenya visited CAZRI, Jodhpur to study this public- private participatory model because this activity also provided a scope of *P. juliflora* management in addition to up-lifting the livelihood of the rural community **(see annex 2).**

B. Entrepreneur farmers' group

As majority of households in target villages are in low to very low income groups, therefore it

Group 1 Village –Lal Pura (Chitalwana), Tehsil – Sanshore, District-Jalore (Rajasthan)

Name of farmer	Status in group	Activity
Jaikishan Vishnoi	Chairman	• Pod collection, processing and marketing for production of value added products • Cutting of side branches in *P. juliflora* thickets for selling to electric power plant
Girdhari Nain	Secretary	
Surjan Ram	Executive Member	
Ashu Ram	Executive Member	

Group 2 Village – Sayara Dhanni (Chitalwana), Tehsil – Sanchore, Dist.-Jalore (Rajasthan)

Name of farmer	Status in group	Activity
Parsa Ram	Chairman	• Pod collection, processing and marketing for production of value added products • Cutting of side branches in *P. juliflora* thickets for selling to electric power plant
Mohan Lal	Secretary	
Pola Ram	Executive Member	
Ashu Ram S/O Harsan	Executive Member	

Group 3 Village – Khanpur, Tehsil – Bhinmal, District Jalore (Rajasthan)

Name of farmer	Status in group	Activity
Mangla Ram	Chairman	• Pod collection, processing and marketing for production of value added products • Cutting of side branches in *P. juliflora* thickets for selling to electric power plant
Sujan Singh	Secretary	
Ramu Lal	Executive Member	
Paras Mal	Executive Member	
Nanji Ram Devasi	Executive Member	

Group 4 Village – Gajipura, Tehsil – Bhinmal, District Jalore (Rajasthan)

Name of farmer	Status in group	Activity
Durg Singh	Chairman	• Pod collection, processing and marketing for production of value added products • Cutting of side branches in *P. juliflora* thickets for selling to electric power plant
Swami Meghwal	Secretary	
Babu Bheel	Executive Member	
Shetan Singh	Executive Member	

was not possible for us to go for organized collection of pods. During first year of the sub-project we could get only to three tons of pods and that too with very difficulty. To solve

7. Process/ Product/Technology/ Value Chain/ Rural Industry Developed*

S. No.	(Process/Product/Technology/ Value Chain/ Rural Industry Developed	Adoption/ Validation/ Commercialization, etc.	Responsible Partner
Process / Product			
1	*Prosopis juliflora* seed gum – An alternatives source of guar gum/ ENDOSPERM GUM	Validated	CAZRI, Jodhpur
2	Identification of the antioxidant compound from *Prosopis juliflora* wood/ MESQUITOL	Validated	CAZRI, Jodhpur
3	Isolation of **Edible Protein** from *Prosopis juliflora* seed/ edible protein for human consumption	Validated	CAZRI, Jodhpur
4	Gum exudation from *Prosopis juliflora* (Exuded Gum)	Product validated however, the testing of various attributes of the gum is in progress at IINRG, Ranchi	CAZRI, Jodhpur and IINRG, Ranchi
5	sweet pod bearing *Prosopis* plant types products (*Cussar* powder, Doughnuts, Biscuits and *Laddoo*)	Products validated	CAZRI, Jodhpur
Production Technology			
1	Cheaper Concentrate Ration	Validated and Commercialized	CAZRI, Jodhpur/ National Food Product (India) Jodhpur and Amrti Agro Industry, Jodhpur
2	Multi-nutrient block	Validated and Pilot scale production at CAZRI, Jodhpur / Regular sale through ATIC, CAZRI, Jodhpur	CAZRI, Jodhpur
3	*Prosopis juliflora* pod based feed block	Validated and Pilot scale production at CAZRI, Jodhpur / Regular sale through ATIC, CAZRI, Jodhpur	CAZRI, Jodhpur
4	Instant Julii coffee	Validated on the verge of commercialization	CAZRI, Jodhpur/ National Food Product (India) Jodhpur/ NIN, Hyderabad
5	*Prosopis juliflora* based Juli Syrup and pod based fine flour.	Validated	CAZRI, Jodhpur

*Details of technologies are given in pro-forma 1, 2 and 3

these problems we selected some rich and influential farmers in each target village. They were sensitize regarding benefit of pod collection and grading; and selling side branches from *P. juliflora* thickets to Transtech Green Power Ltd., Chitalwana. After the group discussions in each village, some influential farmers gave their consent to accomplish the task. We formed one such group in each target village. Organizations of groups are mentioned above. These groups started purchasing the pods by paying cash for the pods @ Rs. 3.5 /kg. Thus, the pod collection, grading, storing and transportation to industrial units got momentum. Side by side these influential farmers provided their tractors and trolleys to other farmers on diesel payment basis to carry the collected *Prosopis* wood to Transtech Green Power Ltd., Chitalwana This activity gave great impetus to our value chain **(see annex 3 & 4)**.

8. Patents (Filed/Granted) : NA

S. No.	Title of Patent	Inventor(s) (Name & Address)	Filed/Published/Granted (No./Date)	Responsible Partner

9. Linkages and collaborations

S. No.	Linkages developed (Name & Address of Organization)	Date/Period From-To	Responsible Partner
1	National Institute of Nutrition, Hyderabad	2011 to 2014	CAZRI, Jodhpur
2	IINRG, Namkum, Ranchi	2013- 2014	CAZRI, Jodhpur
3	Arid Forest Research Institute (AFRI), Jodhpur	2009-2014	CAZRI, Jodhpur
4	Transtech Green Power Ltd., Chitalwana, Jalore, Rajasthan	2010-2014	CAZRI, Jodhpur
5	Amrit Agro Industry, Jodhpur	2011-2014	CAZRI, Jodhpur
6	Abellon CleanEnergy Limited, Ahemdabad	2009-2012	CAZRI, Jodhpur
7	Society for promotion of wasteland development (SPWD), New Delhi	2010- 2014	CAZRI, Jodhpur
8	Samagra Vikas Sansthan, Jhunjhnu, Rajasthan	2010- 2014	CAZRI, Jodhpur
9	Sankalp-Taru Founation, NOIDA, U. P.	2012-2014	CAZRI, Jodhpur
10	Indiabulls, Nagaur Chapter, Rajasthan	2013-2014	CAZRI, Jodhpur
11	Gujarat Institute of Desert Ecology, Bhuj, Gujarat	2010-2014	CAZRI, Jodhpur
12	KVK of Society to Uplift Rural Economy, Danta, Barmer, Rajasthan	2012-2014	CAZRI, Jodhpur
13	KGDS Renewable Energy Pvt. Ltd, Saravanampatti, Coimbatore, India	2013-2014	CAZRI, Jodhpur
14	Disha Life Sciences Pvt. Ltd. Ahmedabad, Gujarat	2011-2014	CAZRI, Jodhpur
15	Desert Regional Centre, ZSI, Jodhpur	2011-2014	CAZRI, Jodhpur

10. Status on environmental and social safeguard aspects

According to small industry development bank of India report of 2012 for Rajasthan, Industries are classified into Red, Orange and Green categories. For industries in the Red category the application for consent to establish needs to be made to the RSPCB's Head Office. For those in the Orange category, the application is made to the Regional Office. Small Scale Industries (SSIs) in the Red category need to submit a feasibility report on the proposed pollution control measures along with the application form. SSIs in the Orange and Green categories need not submit the feasibility report on environmental safe guards. In the NAIP sub-project only very small industries were involved which belonged to green category. Following environmental and social safeguards are considered in present NAIP sub-project.

Environmental			**Social**		
Positive effect	**Negative effect**	**Mitigation measure taken of minimized the negative effect**	**Positive effect**	**Negative effect**	**Mitigation measure taken of minimized the negative effect**
Management of *P. juliflora* thickets	Products, packaging and marketing in non-degradable packaging material.	Degradable packaging material has been introduced for packaging *P. juliflora* pod based animal feed, and Multi nutrient & complete feed blocks.	Organized collection of *P. juliflora* pods by forming groups of farmers' of all economic levels enhanced mutual trust among different communities.	-	-
Opportunities for higher carbon sequestration			Improved livelihood security through additional income generation.		
Arresting soil erosion/Sand & Sand dunes stabilization		*Instant Juli Coffee* is now been packed in glass container	Green belt establishment through TOF in target villages.		

11. Constraints, if any and Remedial Measures Taken

Constraints and problems	Remedial measures taken
Though *P. juliflora* was in abundance around target villages and farmers were using it for cooking and energy needs, however due to complete ignorance regarding usefulness of species it had been very difficult to convenience the farmers to go for pod collection in the initial stage of sub-project.	We started group discussions with the farmers and showed them the processed products from the pods of species. Even many times we prepared Instant Juli coffee in front of farmers and gave it to them to drink. It took complete one year to convenience the farmer to go for pod collection.
Once the pod collection work started in the target villages, the major problem faced by us that how can pods be purchased from the farmers because individual farmers were collecting 50- 100 kg pods/ month. Moreover, there was another major problem i.e. the transportation.	With repeated interactions with the farmers, we organized one group in each target village of rich and inflectional farmers who can purchase the pods. We organized the groups **(the details are given in innovation section of present report)**. With passage of time we established a very good pod collection, grading and primary value addition centre at village Lalpura, Sanchore. These activities smoothly facilitated large scale pod collection from target sites.
Due to thorny nature of the species, the collection of pods was not an easy task and farmers complained about this problem and as well as very low return from the activities.	We included Transtech Green Power Ltd., Chitalwana as a voluntary partner **(Seen annex-2).** This linkage proved to be a boon for us as farmers received very good returns through purchase of side branches of the species for running the power plant.
Popularization of *P. juliflora* pod based products for livestock consumption was very difficult as farmers had the belief that eating *P. juliflora* pods create serious jaw problem in livestock.	We conducted many visits of farmers at our KVK, where experimentations on *P. juliflora* pod based products for livestock consumption were in progress. Moreover, we supplied *P. juliflora* pod based products for livestock consumption to the farmers free of cost for 2-3 months period. During these periods a veterinarian visited fortnightly to the households of each target farmers who are given these products to feed the livestock. This convinced the farmers that *P. juliflora* pod based products for livestock consumption are safe and more nutritive as milk yield increased in every case.
Industrial partner National Food Product (India), Jodhpur initially marketed *P. juliflora* based animal feed in local market in the brand name of "*Kajari Pashu Aahar*" but, he repeatedly complained that by name of *P. juliflora* livestock keepers are not accepting the product to the extent as was thought. Latter on the industrial partner did not showed much interest and he down scaled the production.	We roped another industrialist (Amrit Agro Indistry, Jodhpur) as a voluntary partner in the sub-project. He started the marketing the product in the brand name of *" Amrit Pashu Aahar"*. Till date he has sold *Amrit Pashu Aahar* in substantial quantum and earned Rs. 50.75 lacs (gross returns) till date since December 2012. the day the production was started

12. Publications (As per format of citation in Indian Journal of Agricultural Sciences)

A. Research papers in peer reviewed journals.

S. No.	Authors, Title of the paper, Name of Journal, Year, Vol. & Page No.	NAAS Ratings	Responsible Partner
1	Bohra HC, Patel AK, Mathur BK and Rohilla PP (2008). Multi- nutrient feed block: An Appropriate mean for supplementation of essential nutrients to desert livestock, *Den News* 10 (2): 2-3	-	CAZRI, Jodhpur
2	Rathakrishnan, P. Tewari, J. C., Harsh L. N. and Roy, M. M. (2012) Thorn-less Prosopis sweet pod plant type in Rajasthan- silvical practices and its acceptance by people. *Crop Improvement*, Special issue 323-324	C-110; 3.7	CAZRI, Jodhpur
3	Tewari, J. C., Mathur, B. K., Tewari, P., Singh, Yogendra, Singh, Manmohan, Ram, Moola and Sharma Anil (2013) *Prosopis juliflora*: *A Miracle species of hot arid and semi-arid regions of India. Popular Kheti*, 1(2): 53-59	-	CAZRI, Jodhpur
4	Tewari J. C. (2014) *Value chain of value added products derived from Prosopis juliflora: a complete assesment. Current Agriculture* (in press)	-	CAZRI, Jodhpur
5	Sirohi A. S., Mathur B. K., Misra A. K., Patel A. K. and J. C. Tewari. (2014) Effect of feeding of *Prosopis juliflora* supplement fodder blocks on performance of arid goats, *Veterinary Practitioner* (In press)	V019; 6.0	CAZRI, Jodhpur

B. Books/ Book chapters/ Abstracts/ Popular articles, Brochures, etc.

S. No.	Authors, Title of the papers Name of Book/ Seminar/ Proceedings/Journal, Publisher, Year, Page No.	Responsible Partner
Books		
1	Tewari JC, Rathakrishnan P, Harsha SL and Bohra HC (eds.). 2011. *Prosopis juliflora: Past, Present and Future*, Desert Environmental Conservation Association (DECO), Jodhpur and CAZRI, Jodhpur, 115p	CAZRI, Jodhpur
2	Anonymous (2011) *Prosopis juliflora: Past, Present and Future*: *Discussion Paper*s, CAZRI, Jodhpur, 38p	CAZRI, Jodhpur
3	Tewari JC, Rathakrishnan P , . Khan HA and Ram Moola (eds.) (2012). Utilization of *Prosopis juliflora*: *Challenges and Opportunities; Discussion Paper*s, CAZRI, Jodhpur, 72p	CAZRI, Jodhpur
4	Tewari JC, Rathakrishnan P., Mathur BK, Singh Yogendra, Sharma Anil and Singh Naveen (eds.) 2013. *Prosopis juliflora*: *Retrospect and Prospects*: *Dialogue papers,* Central Arid Zone Research Institute, Jodhpur, 59p	CAZRI, Jodhpur

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Book Chapters		
1	Tewari, JC. and Harsh, LN. (2009) *Prosopis juliflora*: Conflict between valuable resource and noxious weed. In: *Prosopis*: *Ecological, Economic Significance and Management Challenges.* (eds.) Thivakaran GA., Kumar A., Prusty B.AK. and Sunderraj SFW. , Gujarat Institute of Desert Ecology, Bhuj-Kachchh, pp. 72-77.	CAZRI, Jodhpur
2	Harsh LN, Tewari JC (2009) *Prosopis juliflora* (Schwartz) DC, A fast growing tree to blossom the desert and its utilization. In: *Prosopis*: *Ecological, Economic Significance and Management Challenges.* (eds.) Thivakaran G.A., Kumar A., Prusty BAK. and Sunderraj SFW. , Gujarat Institute of Desert Ecology, Bhuj-Kachchh, pp. 60-71.	CAZRI, Jodhpur
3	Dayal Devi, Shamsudheen M, Meena SL, Ram Bhagirath, Harsh LN and Swami ML. (2009). Biomass production of *Prosopis juliflora* and associated changes in soil organic carbon in degraded soils of Kachch region of Gujarat In: *Prosopis*: *Ecological, Economic Significance and Management Challenges.* (eds.) Thivakaran G.A., Kumar A., Prusty BAK. and Sunderraj SFW. , Gujarat Institute of Desert Ecology, Bhuj-Kachchh, pp. 26-27.	CAZRI, Jodhpur
4	Shamsudheen M, Dayal Devi, Meena SL, Ram Bhagirath, Harsh LN and Swami ML. (2009). Dynamics of soil properties and carbon stock under *Prosopis juliflora* in different regions of Kachch, Gujarat. In: *Prosopis*: *Ecological, Economic Significance and Management Challenges.* (eds.) Thivakaran G.A., Kumar A., Prusty BAK. and Sunderraj SFW. , Gujarat Institute of Desert Ecology, Bhuj-Kachchh, pp. 32-33.	CAZRI, Jodhpur
5	Shamsudheen M, Dayal Devi, Meena SL, Ram Bhagirath, Harsh LN and Swami ML. (2009). Impact of *Prosopis juliflora* on different fractions of potassium in soils of Kachch region of Gujarat. In: *Prosopis*: *Ecological, Economic Significance and Management Challenges.* (eds.) Thivakaran G.A., Kumar A., Prusty BAK. and Sunderraj SFW. , Gujarat Institute of Desert Ecology, Bhuj-Kachchh, pp. 34-36.	CAZRI, Jodhpur
6	Tewari JC (2011) Value chain of value added products derived from *Prosopis juliflora*. 6th National Conference on Krishi Vigyan Kendra – 2011: *Enabling Farmers for Secondary Agriculture – Souvenir.* ICAR, New Delhi & JNKVV, Jabalpur (MP), pp.71-76.	CAZRI, Jodhpur

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7	Tewari JC, Ram Moola, Singh Manmohan, Singh Yogendra and Sharma Anil. (2011) *Prosopis juliflora*: from royal tree to disaster and beyond. In: *Prosopis juliflora: Past, Present and Future*, (eds.) Tewari JC, Rathakrishnan P, Harsha SL and Bohra HC, CAZRI, Jodhpur pp. 1-7	CAZRI, Jodhpur and DECO, Jodhpur
8	Harsh LN (2011) Invasive *Prosopis juliflora* to improve the livelihood: a global perspective. In *Prosopis juliflora: Past, Present and Future*, (eds.) Tewari JC, Rathakrishnan P, Harsha SL and Bohra HC, CAZRI, Jodhpur pp. 9-16	CAZRI, Jodhpur and DECO, Jodhpur
9	Bohra HC, Harsh LN, Mathur BK, Kushwaha HL. (2011) Studies of nutrient content of *Prosopis juliflora* pods and its milling products. In: *Prosopis juliflora: Past, Present and Future*, (eds.) Tewari JC, Rathakrishnan P, Harsha SL and Bohra HC, CAZRI, Jodhpur pp. 19-40	CAZRI, Jodhpur and DECO, Jodhpur
10	Mathur BK, Mathur AC, Tewari JC, Bohra HC and Harsh LN. (2011) Incorporation of *Prosopis juliflora* pod powder as ingredient of low cost and highly nutritious concentrate mixture for livestock feed. In: *Prosopis juliflora: Past, Present and Future*, (eds.) Tewari JC, Rathakrishnan P, Harsha SL and Bohra HC, CAZRI, Jodhpur pp. 41-51	CAZRI, Jodhpur and DECO, Jodhpur
11	Tewari Pratibha, Tewari JC, Harsh LN and Bohra HC. (2011) *Prosopis juliflora*: a women friendly tree. (*in*) *Prosopis juliflora: Past, Present and Future*, In: *Prosopis juliflora: Past, Present and Future*, (eds.) Tewari JC, Rathakrishnan P, Harsha SL and Bohra HC, CAZRI, Jodhpur pp. 53-59	CAZRI, Jodhpur and DECO, Jodhpur
12	Azam, MM, Tewari JC, Harsh, LN and Bohra HC. (2011) Products of economic importance from *Prosopis juliflora.* In: *Prosopis juliflora: Past, Present and Future*, In: *Prosopis juliflora: Past, Present and Future*, (eds.) Tewari JC, Rathakrishnan P, Harsha SL and Bohra HC, CAZRI, Jodhpur p. 61-65	CAZRI, Jodhpur and DECO, Jodhpur
13	Rathakrishnan P and Tewari JC. (2011) Multi dimension of mesquite on production, conservation and value addition and aspects. In: *Prosopis juliflora: Past, Present and Future*, (eds.) Tewari JC, Rathakrishnan P, Harsha SL and Bohra HC, CAZRI, Jodhpur pp. 87-94	CAZRI, Jodhpur and DECO, Jodhpur
14	Ram Moola, Tewari JC, Harsh LN, Rathakrishnan P, Singh Manmohan, Singh Yogendra and Sharma Anil. (2011) *Prosopis juliflora*: weed or wealth – a review. In: *Prosopis juliflora: Past, Present and Future*, (eds.) Tewari JC, Rathakrishnan P, Harsha SL and Bohra HC, CAZRI, Jodhpur pp. 105-115	CAZRI, Jodhpur and DECO, Jodhpur

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15	Gajja B L, Tewari P and Lohia J K. (2011). Socio-economic impact of *Prosopis juliflora* in arid zone of Rajasthan. I*n: Prosopis juliflora: Past, Present and Future*, (eds.) Tewari JC, Rathakrishnan P, Harsha SL and Bohra HC, CAZRI, Jodhpur pp. 95-102.	CAZRI, Jodhpur and DECO, Jodhpur
16	Khan Hamid A. (2011). Occurance of Triacontanol in *Prosopis juliflora*. *In: Prosopis juliflora: Past, Present and Future*, (eds.) Tewari JC, Rathakrishnan P, Harsha SL and Bohra HC, CAZRI, Jodhpur pp. 103-104	CAZRI, Jodhpur and DECO, Jodhpur
Abstracts		
1	Azam, M.M.; Singh Y., Bohra H.C. and Harsh L.N. (2009). Standardization of techniques for isolation of gum and concentrationed protein from the seeds of *P. juliflora*, pp. 314. In: *Proceeding of International Conference on "Nurturing Arid Zones for People and the Environment: Issues and Agenda for 21st century*", CAZRI, Jodhpur, pp. 88.	CAZRI, Jodhpur
2	Harsh, LN.; HC. Bohra; Mathur BK.; Tewari JC. Azam MM. and Kushwah HL. (2009). Chemical composition of *P. juliflora* and *P. pallida* pods and their milling products, In: *Proceeding of International Conference on "Nurturing Arid Zones for People and the Environment: Issues and Agenda for 21st century"*, CAZRI, Jodhpur, pp.312 .	CAZRI, Jodhpur
3	Kushwah, HL., Harsh LN.; Bohra HC. Mathur BK. and Tewari JC., 2009. Modification of multipurpose pod thresher for *Prosopis juliflora* pod processing. In: *Proceeding of International Conference on "Nurturing Arid Zones for People and the Environment: Issues and Agenda for 21st century"*, CAZRI, Jodhpur, pp. 88.	CAZRI, Jodhpur
4	Mathur, BK. Harsh LN, Mathur AC., Kushwah HL, Bohra HC Prajapati Dinesh and Tewari JC., (2009). Acceptability and palatability of easily processed, balanced and cheaper concentrate mixture containing *P. juliflora* pods in lactating *Tharparkar* cattle. *In: Proceeding of International Conference on "Nurturing Arid Zones for People and the Environment: Issues and Agenda for 21st century"*, CAZRI, Jodhpur, pp. 242.	CAZRI, Jodhpur
5	Tewari, Pratibha; Seena M. and Harsh LN. (2009). Assuming food security in arid zones through development of food products from non-traditional food plants,. In: *Proceeding of International Conference on "Nurturing Arid Zones for People and the Environment: Issues and Agenda for 21st century"*, CAZRI, Jodhpur pp. 292	CAZRI, Jodhpur
6	Ram Moola, Tewari JC, Singh Y, Singh M and Sharma A. (2011). *Prosopis juliflora*: A Valuable shrub for arid and semi-arid regions. In: *Proc. National Workshop on "Prosopis juliflora: Past, Present and Future"* Central Arid Zone Research Institute, Jodhpur (Rajasthan), pp. 37	CAZRI, Jodhpur **Contd…**

7	Bohra HC, Tewari JC, Harsh LN, Sharma Anil, Singh M, Singh Y and Ram Moola (2011). Potential of organic feed production from *Prosopis juliflora* pods. In: *National Symposium-cum-Brainstorming Workshop on Organic Agriculture,* CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur (H.P.), India pp. 134.	CAZRI, Jodhpur
8	Tewari JC, Ram Moola, Singh Manmohan and Singh Naveen (2011). *Prosopis juliflora* for livelihood improvement. In: *Proc. National Symposium on Resource Utilization through Integrated Farming System and Biodiversity Conservation in Drylands*, RRS, CAZRI, Kukma, Bhuj, pp.44.	CAZRI, Jodhpur
9	Tewari JC**,** Azam MM, Singh Yogendra, Sharma Anil, Ram Moola and Lohia JK (2011). *Prosopis juliflora* (Vilayati Babool) : Valuable resource in dry lands of India. In: *Proc. National Symposium on Resource Utilization through Integrated Farming System and Biodiversity Conservation in Drylands* RRS, CAZRI, Kukma, Bhuj, pp.45.	CAZRI, Jodhpur
10	Gajja B L, Tewari P and Lohia J K. 2011. Socio-economic impact of *Prosopis juliflora* in arid zone of Rajasthan. In: *Proc. National Workshop on "Prosopis juliflora: Past, Present and Future",* Central Arid Zone Research Institute, Jodhpur (Rajasthan), pp. 9.	CAZRI, Jodhpur
11	Bohra H C, Harsh L N, Mathur B K and Kushwaha H L. 2011. Chemical composition of various milling products of *Prosopis juliflora* and *P. pallida* pods. In: *Proc. National Workshop on "Prosopis juliflora: Past, Present and Future",* Central Arid Zone Research Institute, Jodhpur (Rajasthan), pp. 17.	CAZRI, Jodhpur
12	Bohra H C, Harsh L N, Mathur B K and Sharm Anil. 2011. Value added feed products from *Prosopis juliflora* pod milling products. In: *Proc. National Workshop on "Prosopis juliflora: Past, Present and Future"*, Central Arid Zone Research Institute, Jodhpur (Rajasthan), pp. 19.	CAZRI, Jodhpur
13	Mathur B K, Mathur A C and Singh Manmohan. 2011. Formulation and evaluation of cheaper and balanced concentrate. In: *Proc. National Workshop on "Prosopis juliflora: Past, Present and Future"*, Central Arid Zone Research Institute, Jodhpur (Rajasthan), pp. 30.	CAZRI, Jodhpur
14	Ram Moola, Tewari J C, Singh Y, Singh M and Sharma A. 2011. *Prosopis juliflora*: A Valuable shrub for arid and semi-arid regions. In: *Proc. National Workshop on "Prosopis juliflora: Past, Present and Future",* Central Arid Zone Research Institute, Jodhpur (Rajasthan), pp. 37.	CAZRI, Jodhpur
15	Bohra H C, Tewari J C, Harsh L N, Sharma Anil, Singh M, Singh Y and Ram Moola 2011. Potential of organic feed production from *Prosopis juliflora* Pods. In: *Proc. National Symposium-cum-Brainstorming Workshop on Organic Agriculture,* CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur (H.P.), India pp. 134.	CAZRI, Jodhpur **Contd…**

16	Kalia Rajwant K., Ratha Krishnan P. and Tewari J. C. (2012). Genetic improvement of *Prosopis* - Need and scope in arid regions. In: *Proc. of National Symposium on "Managing stress in Dry lands under Climate Change Scenarios* AZRAI & CAZRI, Jodhpur. pp. 257 - 259.	CAZRI, Jodhpur
17	Singh Y., Tewari J.C., Sharma A. and Ram M. (2012). CAZRI's effort in building *Prosopis juliflora* a valuable resource of livelihood in arid and semi- arid regions. In: Proc. *Symposium on Managing Stress in Drylands under Climate Change Scenarios*. AZRAI & CAZRI, Jodhpur, pp. 243.	CAZRI, Jodhpur
18	Tewari J.C., Singh Y., Tripathi S., Sharma A. and Singh N. (2012). Chemical constituents of *Prosopis juliflora* pods. In: Proc. *Symposium on Managing Stress in Drylands under Climate Change Scenarios*., AZRAI & CAZRI, Jodhpur pp. 161.	CAZRI, Jodhpur
19	Kalia Rajwant K., Ratha Krishnan P. and Tewari J. C. (2013). Biotechnological interventions in *Prosopis* - current status and future prospects. In: *Proc. of National workshop on Prosopis juliflora – Retrospect and Prospects* CAZRI, RRS, Kukma-Bhuj (Gujarat) India, pp. 14 – 15.	CAZRI, Jodhpur
20	Mathur, B.K., Mathur, A.C., Sirohi, A.S., Rathakrishnan, P., Thada, M. and Tewari, J.C. (2013). Feeding of cheaper and balanced concentrate mixture containing *Prosopis juliflora* pods for growing heifers and male calves. In: "*Proc. National workshop on Prosopis juliflora – Retrospect and Prospects",* CAZRI, RRS, Kukma-Bhuj (Gujarat) India pp. 21-22.	CAZRI, Jodhpur
21	Rathakrishnan P., Tewari J.C. and Pradhnaram (2013). *Prosopis* species availability, adaptability and acceptance analysis in arid and semi arid India. In: *Proc. National workshop on "Prosopis juliflora – Retrospect and Prospects",* CAZRI, RRS, Kukma-Bhuj (Gujarat) India pp. 27-28.	CAZRI, Jodhpur
22	Singh Y., Tewari J.C., Pareek K., Tripathi S., Sharma A., Choudhary V. and Rathore S.S. (2013). *Prosopis juliflora* seed: chemical composition and potential uses. In: *Proc. National workshop on "Prosopis juliflora – Retrospect and Prospects",* CAZRI, RRS, Kukma-Bhuj (Gujarat) ,India, pp. 56.	CAZRI, Jodhpur

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23	Sirohi A.S., Mathur B.K. Misra A.K., Patel A.K. and Tewari J.C. (2013). Performance of goats fed with concentrate mixture having non-grinded (as such) dried *Prosopis juliflora* pods. In Proc. *National workshop on "Prosopis juliflora – Retrospect and Prospects",* CAZRI, RRS, Kukma-Bhuj, (Gujarat), India, pp. 55.	CAZRI, Jodhpur
24	Sirohi A.S., Mathur, B.K., Patel. A.K., Misra. A.K. Tewari. J.C. Tailor, M. and Sharma A. (2013). Effect of *Prosopis juliflora* pods feeding on the performance of growing goats. *Proc. National Seminar on "New Paradigms in Livestock Production: From Traditional to Commercial Farming and Beyond"* NDRI, Karnal pp.32.	CAZRI, Jodhpur
25	Tewari J.C. Tripathi S., Singh Y., Sharma A. and Singh P. (2013). Misciblity of *Prosopis juliflora* roasted pulp flour. In: Proc. *National workshop on "Prosopis juliflora: Retrospect and Prospects"*, CAZRI, RRS, Kukma, Bhuj (Gujarat), India, pp. 35.	CAZRI, Jodhpur
26	Tewari J.C., Pareek K., Singh Y., Singh P., Bishnoi P.R. and Naveen Singh (2013). Gum production from *Acacia nilotica* and *Prosopis juliflora*. In: Proc. *National workshop on "Prosopis juliflora – Retrospect and Prospects*", CAZRI, RRS, Kukma, Bhuj (Gujarat), India pp. 33.	CAZRI, Jodhpur
27	Tewari J.C., Pareek K., Tripathi S.,Tailor M., Lohia J.K. and Sharma A. (2013). Conserved domains of Tau class GSTs in *Prosopis juliflora.* In: Proc. *National workshop on "Prosopis juliflora – Retrospect and Prospects*", CAZRI, RRS, Kukma, Bhuj (Gujarat), India,pp. 34	CAZRI, Jodhpur
Popular Articles		
1	Singh Yogender, Ram Moola, Tewari J. C. and Harsh L. N. (2013) Aapada nahi sampada hai vilayati babool. *Kheti* 66 (3): 22-24 (*in Hindi*)	CAZRI, Jodhpur
2	Ram Moola, Tewari J. C. and Harsh L. N. (2013) Shusks kshestrow mai krishi vaniki, *Kheti* 66 (3): 28-29 (*In Hindi*)	CAZRI, Jodhpur

13. Media Products Developed/Disseminated

Year	Brochures - Title	No. of copies	Distribution
Bulletins / Brochures			
2009	Tewari, JC, Harsh, LN and Vittal KPR, (2009) *Advantage! Prosopis juliflora*., CAZRI, Jodhpur, 5 p.	1000	996
2011	Azam MM, Tewari JC and Harsh LN, (2011) *Prosopis juliflora*: *an alternative source of guar gum.*, CAZRI, Jodhpur, 5 p.	500	490
	Azam MM, (2011) *Prosopis juliflora*: *A Rich Source of Antioxidant Product*, CAZRI, Jodhpur 3 p.	250	215
	Bohra HC, Harsh LN, Mathur BK, Sharma Anil and Roy MM (2011) *Utilization of Value Added Prosopis juliflora Pod Milling Products for Production of Livestock Feeds*, CAZRI, Jodhpur, 5p.	1000	998
	Tewari JC, Kumar S and Bishnoi PR (2011) *NAIP Sub-Project on Value Chain on Value Added Products Derived from Prosopis juliflora: at a Glance*. CAZRI, Jodhpur. 3 p.	500	402
	Mathur BK, Bohra HC, Harsh LN, Patel AK and Roy MM (2011) *Economic Feeding of Goat and Sheep Utilizing Non- conventional Resources of Arid Region*, CAZRI, Jodhpur, 5 p.	1000	970
2011	Mathur BK, Mathur AC, Tewari JC and Roy MM. 2011. *Development and evaluation of Prosopis juliflora pods mixed cheap and balanced feed for lactating cattle*. Central Arid Zone Research Institute, Jodhpur 5 p.	500	422
2012	Tewari Pratibha (2012) *Fuel Wood Option in Hot Arid Zone*, CAZRI, Jodhpur 3 p.	500	476
2013	Mathur BK, Mathur AC, Tewari JC and Roy MM (2013), *Angraji Babool Phali Churn Yakut Sasta Pashu Aahar*, CAZRI, Jodhpur, 3p. (*in Hindi*)	1000	998
	Tewari Pratibha, Tripathi Shweta, Sharma Anil and Roy M. M.. (2013). *About Julii Coffee*. CAZRI, Jodhpur, 3p.	1500	1459

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2009-2012	News headlines several times in local and national papers including Economic Times and also wide coverage by electronic media time to time	Not countable	-
Brochures			
2012	Rathakrishnan P, Tewari JC, Singh A, Ram M, Singh N, Sharma A, Singh, Y and Singh M. (2012). *Shushk Kshetra ke Mahatavpurn Vrikshon ki Podhshala Teyar Karne ki Taknik*. CAZRI, Jodhpur. .(*in Hindi)*	1500	1490
	Rathakrishnan P, Tewari JC**,** Gajja BL, Singh P, Singh N, Singh Y, Singh M and Sharma A. (2012). *Vilayati Babool: Mulya Sanvardhit Utpad.* Central Arid Zone Research Institute, Jodhpur. (*in Hindi*).	1500	1410
	Mathur BK (2012) *Maru Kshetron mai Sukhe ke Samaya Pashu Poshan Prabhandhan,* CAZRI, Jodhpur. (*in Hindi*).	1500	1397
CD			
2012	Value Chain on Value Added Products Derived from *Prosopis juliflora*	100	90

14. Meetings/Seminars/Trainings/Kisan Mela, etc. organized

S. No.	Details of Meetings/Seminars /Trainings, etc.	Duration (From-To)	No. of Personnel Trained	Budget (Rs.`)	Organizer (Name & Address)
Workshop					
1	NAIP- National Work on *Prosopis juliflora*: Past, Present and Future	23rd to 24th March, 2011	100, delegates from different part of country including one from Kenya participated	2.31 lacs	CAZRI, Jodhpur
2	NAIP- All India Workshop on "Utilization of *Prosopis juliflora*: Challenges and Opportunities"	12th and 13th March, 2012.	130 delegates from different part of country participated	2.99 lacs	CAZRI, Jodhpur

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3	NAIP- National Workshop on "*Prosopis juliflora*: Retrospect and Prospects	26th to 28th February, 2013	110 delegates from different part of country participated	3.50 lacs	CAZRI, Jodhpur
Field Days					
1	Awareness programme on *P. juliflora* management	1st June, 2009	30 farmers	-	CAZRI, Jodhpur
2	Awareness programme on *P. juliflora* management	16th July, 2009	50 farmers	-	CAZRI, Jodhpur
3	Nursery techniques for raising of seedling of sweet pod bearing plant type	3rd December, 2010	36 farmers	-	CAZRI, Jodhpur
4	Preparation of *P. juliflora* pod based feed at the door steps	4th February , 2011	45 farmers	-	CAZRI, Jodhpur
5	Preparation of *P. juliflora* pod based feed at the door steps	8th February, 2011	56 farmers	-	CAZRI, Jodhpur
6	Management of *P. juliflora* thickets for higher pod production	10th March, 2011	76 farmers	-	CAZRI, Jodhpur
7	Demonstration of Products processed for livestock consumption	23rd December, 2011	96 farmers	-	CAZRI, Jodhpur and DECO, Jodhpur
8	Awareness programme on *P. juliflora pod* collection and distribution of *P. juliflora* pod based multi-nutrient blocks for trials.	5th January,2012	52 farmers	-	CAZRI, Jodhpur

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9	Awareness programme on *P. juliflora pod* collection, grading and primary value addition	25th January, 2012	36farmers	-	CAZRI, Jodhpur
10	Awareness programme on *P. juliflora pod* collection, grading and primary value addition	11th February , 2012	81farmers	-	CAZRI, Jodhpur
11	Awareness programme on *P. juliflora pod* collection, grading and primary value addition	24th February, 2012	100farmers	-	CAZRI, Jodhpur and DECO, Jodhpur
12	*Prosopis juliflora* day	24th November, 2012	147 farmers	-	CAZRI, Jodhpur
13	Integrating sweet pod bearing palnt types as a woody component in traditional agroforestry system	23rd November, 2013	38 farmers	-	CAZRI, Jodhpur
14	*Prosopis juliflora* day	1st July, 2013	161 farmers	-	CAZRI, Jodhpur
15	Primary processing of *P. juliflora* pods.	6th August, 2013	38 farmers	-	CAZRI, Jodhpur
16	Joint Feedback programme on *P. juliflora* pod based products	25th January, 2014	115 farmers	-	CAZRI, Jodhpur
Group Discussions					
1	Introductory discussion on *P. juliflora* management	6th January, 2012	25 farmers	-	CAZRI, Jodhpur and DECO, Jodhpur
2	*Vilayati babool: Mulya Sanvardhit Utpad*	26th January, 2012	42 farmers	-	CAZRI, Jodhpur

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3	How can value added *P. juliflora* pod based products can be processed at household scale	12th February, 2012	36 farmers	-	CAZRI, Jodhpur
4	Discussion on steps necessary for post NAIP sustainability	26th September, 2013	28 farmers	-	CAZRI, Jodhpur
5	Discussion on steps necessary for post NAIP sustainability	25th November, 2013	24 farmers	-	CAZRI, Jodhpur
6	Joint Feedback programme on *P. juliflora* pod based products	26th January, 2014	65 farmers	-	CAZRI, Jodhpur
Trainings					
1	Importance of *P. juliflora* pods (on-campus)	27th March, 2009	45 farmers	-	CAZRI, Jodhpur and DECO, Jodhpur
2	*P. juliflora* stand management (off-campus)	26th May, 2009	53 farmers	-	CAZRI, Jodhpur
3	*P. juliflora* stand management (off-campus)	28th May, 2009	68 farmers	-	CAZRI, Jodhpur
4	Pod collection, grading and storage (off- campus)	1st January,2010	78 farmers	-	CAZRI, Jodhpur
5	Primary value addition on Pods and technology for preparing animal feed (on-campus)	28th February, 2011	32 farmers	-	CAZRI, Jodhpur and DECO, Jodhpur
6	Nursery raising technique for sweet pod plant type *Prosopis* species (off- campus)	8th January, 2012	56 farmers	-	CAZRI, Jodhpur
7	Promotion of managed *P. juliflora* plantation (off-campus)	24th November, 2013	22 farmers	-	CAZRI, Jodhpur

Contd…

8	Promotion of managed *P. juliflora* plantation (off- campus)	22nd March, 2013	104 farmers	-	CAZRI, Jodhpur
9	Gum exudation from *P. juliflora* (Off campus)	26th April, 2013	66 farmers	-	CAZRI, Jodhpur
10	Steps required by farmers for post NAIP sustainability (off- campus)	3rd September, 2013	76 farmers	-	CAZRI, Jodhpur
11	*Prosopis juliflora* pod based feed block utilization (off- campus)	18th January, 2014	30 farmers	-	CAZRI, Jodhpur

15. Participation in Conference/ Meetings/Trainings/ Radio talks, etc.

S. No.	Details of Meetings/Seminars/ Trainings/Radio talk, etc.(Name &Address)	Duration (From-To)	Budget (`)	Participant (Name & Address)
1	National Symposium on "*Prosopis*: Ecological, Economic Significance and Management Challenges" held at GUIDE, Bhuj (Gujarat)	February 20-21, 2009	-	Dr. J. C. Tewari
2	Training on "Monitoring and evaluation for innovation in agriculture" held at Indian Institute of Management, Lucknow, U.P	19th – 23rd October, 2009	-	Mr. Shyam Lal Harsh, DECO, Jodhpur
3	International Conference on "Nurturing Arid Zones for People and Environment: Issues & Agenda for 21st Century" held at Central Arid Zone Research Institute, Jodhpur	Nov.24-28, 2009	-	Dr. J. C. Tewari (CPI), Dr. L.N Harsh (then CPI), Dr. H. C. Bohra, Dr. M. Azam, Yogendra Singh and Anil Sharma
4	Workshop: Consultative Workshop on *Prosopis juliflora.* Organizer: Society for Promotion of Wasteland Development, New Delhi. ***Venue***: Revenue Services Training Centre, Ajmer.	21st – 22nd January, 2010	-	Dr. J. C. Tewari

Contd…

5	Workshop: Annual Workshop of National Project on Vegetation Carbon Pool Assessment. Organizer & venue: Indian Institute of Remote Sensing, Dehra Dun.	11th- 12th March, 2010	-	Dr. J. C. Tewari
6	Annual Workshop of Component – II NAIP. Organizer: NAIP, ICAR. Venue: TNAU, Coimbatore.	14th -15th April, 2010	-	Dr. J. C. Tewari
7	Workshop, World Bank Review: Workshop on Technological Innovation in Indian Agriculture. Organizer: NAIP. Venue: NAAS complex, New Delhi.	20th -21st May, 2010	-	Dr. J. C. Tewari
8	Conference: National Conference on Business Action on Climate Change. Organizer: Confederation of Indian Industries, Jaipur. Venue: SMS Convention Centre, Jaipur, Rajasthan	4th June, 2010	-	Dr. J. C. Tewari
9	Workshop: Stakeholders Workshop of AFRI, Jodhpur. Organizer: AFRI, Jodhpur. Venue: Conference Hall, TREE, Jaipur, Rajasthan	9th & 10th June , 2010	-	Dr. J. C. Tewari
10	Annual Workshop of NAIP Component II, Dharwad, Karnataka	15th -16th March, 2011	-	Dr. J. C. Tewari, Mr. Manmohan Singh and Anil Sharma
11	NAIP- National Work on "*Prosopis juliflora*: Past, Present and Future" held at CAZRI, Jodhpur, Rajasthan	23rd to 24th March, 2011	-	All Team members of present NAIP Sub-Project, including NGOs, Industrial and Voluntary partners
12	National Symposium-cum-Brainstorming Workshop on "Organic Agriculture" held at CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur	April 19-20, 2011	-	Manmohan Singh and Yogendra Singh

Contd…

13	Meeting of sub-group on "feed and fodder" of the working group on animal husbandary and dairying of the Planning Commission, Govt. of India", Venue-CAZRI, Jodhpur	13th May, 2011	-	Dr. J. C. Tewari
14	Training on "Clean Development Mechanism (CDM), carbon trading and REDD+ benefits in forestry sector" Engineering staff college of India, Gachi Bowli, Hyderabad	8th- 10th August, 2011	-	Dr. J. C. Tewari
15	Expert consultation on " Tree Fodder Improvement" NRM Division, ICAR, New Delhi	19th August, 2011	-	Dr. H. C. Bohra
16	"1st Indian Forest Congress 2011" held at NASC Complex, New Delhi	November 22-25, 2011	--	Dr. J. C. Tewari and Manmohan Singh
17	6th National Conference on "Krishi Vigyan Kendra – 2011: Enabling Farmers for Secondary Agriculture" held at JNKVV, Jabalpur (MP).	December 3-5, 2011	-	Dr. J. C. Tewari
18	National Symposium on "Resource Utilization through Integrated Farming System and Biodiversity Conservation in Drylands" held at RRS, CAZRI, Kukma, Bhuj	December 20-22, 2011	-	Manmohan Singh & Yogendra Singh and Anil Sharma
19	" Fodder for sustainable livestock production and environmental security" A Brain Stroming Workshop Under Accelerated Fodder Development Programme, Agriculture Research Station (SKRAU), Keshwana, Jalore	18th -19th February, 2012	-	J. C. Tewari, Manmohan Singh , Yogendra Singh and Anil Sharma
20	NAIP- All India Workshop on "Utilization of *Prosopis juliflora*: Challenges and Opportunities" held at CAZRI, Jodhpur	12th and 13th March, 2012	-	All Team members of present NAIP Sub-Project, including NGOs, Industrial and Voluntary partners

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21	Annual Workshop of NAIP Component II, NDRI, Karnal	27th- 28th March, 2012	-	Dr. P. Rathakrishnan
22	National consultation on "*P. juliflora*," SPWD (New Delhi), held at Jila Parished Auditorium, Ajmer	27th April,2012	-	Dr. J. C. Tewari
23	Business workshop on "Energy Plantation for Sustainable Biomass Power in India" Supported by British High Commission, New Delhi, Dalkia Energy Services, Jaipur	27th April,2012	-	Dr. P. Rathakrishnan
24	National Seminar on "New Paradigms in Livestock Production: From Traditional to Commercial Farming and Beyond" and XX Annual Convention of Indian Society of Animal Production and Management, NDRI, Karnal	28th to 30th Jan.,2013	-	Dr. A.V. Sirohi
25	National Brainstorming Workshop 5th, September,2012, JAISALMER, India (SUMAMAD Project, phase-2), RRS of CAZRI, Jaisalmer.	5th ,Sept. 2012	-	Dr. J. C. Tewari
26	4th CCM of Network Project on HPVA of NRG at IINRG, Ranchi	14-15, Sept. 2012	-	Dr. J. C. Tewari
	10th SUMAMAD Workshop orgnized by UNESCO at Universidad Mayor de San Andrés at La Paz, Bolivia	12-14, Nov,2012	Funds provided by UNESCO, Paris	Dr. J. C. Tewari
27	Symposium on Managing Stress in Drylands under Climate Change Scenario", Arid Zone Research Association of India, CAZRI, Jodhpur	1-2nd December, 2012	-	Dr. J. C. Tewari Dr. (Mrs.) Pratibha Tewari, Dr. B. K. Mathur, Dr. A. V. Sirohi, Dr. P. Rathakrishnan, Dr. H. A. Khan, Yogendra Singh, Miss Shweta Tripathi and Anil Sharma

Contd…

28	NAIP- National Workshop on "*Prosopis juliflora*: Retrospect and Prospects", held at CAZRI, RRS, Kukma, Bhuj, Gujarat	26th - 28th February, 2013	-	All Team members of present NAIP Sub-Project, including NGOs, Industrial and Voluntary partners
29	Annual Workshop of NAIP Component II, New Delhi	10th 11th March, 2013	-	Dr. J. C. Tewari and Mr. Anil Sharma
30	Agri-Tech Investors Meet, 2013 organized at NAAS, New Delhi	18th -19th July, 2013	-	Dr. J. C. Tewari, Dr. B. K. Mathur, Mr. Yogendra Singh and Anil Sharma
31	13th Implementation Support Mission Meeting, National Agricultural Innovation Project, Indian Council of Agricultural Research held at MPAUT, Udaipur	13th- 14th August, 2013	-	Dr. J. C. Tewari, Dr. B. K. Mathur,Mr. Prahlad Singh, Mr. Yogendra Singh and Anil Sharma
32	XXXIII INCA International Congress on "Integrated Decentralized Planning: Geospatial Thinking, ICT & Good Governance" National Remote Sensing Centre (NRSC), ISRO, Jodhpur Central Arid Zone Research Institute (CAZRI), ICAR, Jodhpur	19th -21st September , 2013	-	Dr. (Mrs.) Pratibha Tewari, Mr. Yogendra Singh, Miss Shweta Tripathi and Mr. Anil Sharma
33	14th Rastriya Krishi Vigyan Sangosthi, CIFE, Mumbai	14th – 16th December, 2013	-	Dr. A.V. Sirohi
34	5th CCM of Network Project on HPVA of NRG at	8th -9th October, 2013	-	Dr. J. C. Tewari and Mr. Anil Sharma
35	3rd World Congress on Agroforestry held at Delhi	10th -14th February, 2014	-	Dr. J. C. Tewari

16. Foreign trainings/ undertaken (National/ International) NA

S. No.	Name, Designation and Address of the Person	Place of Training	Area of Training	Time and Duration	Total Cost (`)

17. Performance indicators (from inception to completion)

S. No.	Indicator	Total No.	
1.	No. of production technologies released and/or adopted	4	
2.	No. of processing technologies released and/or adopted	5	
3.	Number of technologies/products commercialized based on NAIP research	3	
4.	No. of new rural industries/enterprises established/ upgraded	1	
5.	No. of product groups for which quality grades developed and agreed	4	
6.	Total no. of private sector organizations (including NGOs) participating in consortium	4+6=10	
7.	No. of farmers involved in consortium activities	380	
8.	Total number of farmers' group developed for marketing and processing	4	
9.	Number of patent/intellectual property protection applications filed based on NAIP research	NA	
10.	Number of patents/intellectual property protections granted/published based on NAIP research	NA	
11.	Number of scientists trained overseas in the frontier areas of science	NA	
12.	Number of scientists trained overseas in consortium-based subject areas	NA	
13.	No. of scientists participated in conference/seminar etc. abroad	NA	
14.	No. of training organized/ farmers trained	11.	630
15.	Success stories	-	
16.	Incremental employment generated (person days/year)	Baseline	Final
		00	10225/year
17.	Increase in income of participating households (` per annum)	Baseline	Final
		00	28800
18.	Number of novel tools/protocols/methodologies developed	-	
19.	**Publications**	2	
	Articles in NAAS rated journals	2	
	Articles in other journals	3	
	Book(s)	4	
	Book chapter(s)	16	
	Thesis	-	
	Popular article(s) (English)	1	
	Newspaper article(s)	Not countable	
	Seminar/Symposium/Conference/Workshop Proceedings/ Abstract	27	
	Technical bulletin(s)	-	
	Manual(s)	-	
	CDs/Videos	1	
	Popular article(s) in other language	2	
	Folder/Leaflet/Handout	14	
	Report(s)	16	

18. Employment generation (man-days/year)

S. No.	Type of Employment Generation	Employment Generation up to End of Sub-project (man days)	Responsible Partner
1	Pod Collection, grading, storing, primary value addition and transportation (on farm level)	12000	CAZRI, Jodhpur, National Food Product (India) and Amrit Agro Industry, Jodhpur (Voluntary Industrial Partner)
2	Pod processing for production of " *Kajri Pashu Aahar*"	1460	National Food Product (India) Jodhpur Industrial partner
3	Pod processing for production of " *Amrit Pashu Aahar*"	5840	Amrit Agro Industry, Jodhpur (Voluntary Industrial Partner)
4	Collection of *P. juliflora* side stem from the thickets and selling them to biomass power generation unit	21600*	Transtech Green Power Ltd, Chitalwana, Sanchor, Jalore

This activity does not support directly to actual value chain, but provided great support to maintain the supply chain of P. juliflora pods. Primary stakeholders earned additional income through additional source, which also boosted P. juliflora pods collection.

19. Assets Generated

(i) Equipment/ vehicles/ research facilities

S. No.	Name of the equipment with manufacturers name, model and Sr. No.	Year of purchase	Quantity (Nos.)	Total cost (Rs.`)	Responsible consortium
1.	Lap Top (HP)	2009	1	Rs. 52,500/-	CAZRI, Jodhpur
2.	Large crusher (CIAE, Bhopal assembled)	2009	1	Rs. 11,475/-	CAZRI, Jodhpur
3.	Small crusher (CIAE, Bhopal assembled)	2009	1	Rs. 8,800/-	CAZRI, Jodhpur
4.	Multipurpose thresher (CIAE, Bhopal assembled)	2009	2	Rs. 57,200/-	CAZRI, Jodhpur
5.	Freezer	2009	1	Rs. 12,400/-	CAZRI, Jodhpur
6.	Digital camera (Sony)	2009	1	Rs. 14,799/-	CAZRI, Jodhpur

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7.	PC based FT IR with printer, room temperature controller	2010	1	JPY 1,89,0000/-	CAZRI, Jodhpur
8.	PC based UVVIS with printer, room temperature controller and UPS	2010	1	US$ 9400/-	CAZRI, Jodhpur
9.	Power saw	2010	1	Rs. 47,880/-	CAZRI, Jodhpur
10.	Desk Top Computers with accessories	2010	2	Rs. 99,400/-	CAZRI, Jodhpur
11.	Pulveriser	2010	1	Rs. 14,250/-	CAZRI, Jodhpur
12.	Digital camera (Nikon)	2010	1	Rs. 14,799/-	CAZRI, Jodhpur
13.	Spray drier	2010	1	Rs. 3,73,920/-	CAZRI, Jodhpur
14.	Crusher	2010-11	1	Rs. 1,14,000/-	NFP, Jodhpur
15.	Vessel	2010-11	1	Rs. 50,000/-	NFP, Jodhpur
16.	Filtration Unit	2010-11	1	Rs. 50,000/-	NFP, Jodhpur
17.	Mixer	2010-11	1	Rs. 50,180/-	NFP, Jodhpur
18.	Drying Unit	2010-11	2	Rs. 1, 58,285/-	NFP, Jodhpur
19.	Packaging Machine	2010-11	1	Rs. 91,800/-	NFP, Jodhpur
20.	3 W Packing machine	2010-11	1	Rs. 6,12,000/-	NFP, Jodhpur
21.	Compressor and parts	2010-11	-	Rs. 56,175/-	NFP, Jodhpur
22.	AC sheets	2010-11	-	Rs. 14,250/-	NFP, Jodhpur
23.	Accessories for machines – Channels, Angels, Flats	2010-11	-	Rs. 52,529/-	NFP, Jodhpur
24.	Electric baking oven	2013-14	1	Rs. 2, 80, 000	CAZRI, Jodhpur
25.	Spiral Mixture	2013-14	1	Rs. 96,000	CAZRI, Jodhpur
26.	Baking Trays	2013-14	24	Rs 9,600	CAZRI, Jodhpur
27.	Table top bread slicer	2013	1	Rs 75,000	CAZRI, Jodhpur
28.	15 tray type final proffer	2013	1	Rs 2, 10,000	CAZRI, Jodhpur
29.	Double pair moulder	2013	1	Rs 2,30,000	CAZRI, Jodhpur
30.	Plant mixture	2013	1	Rs 1,10,000	CAZRI, Jodhpur
31.	Bread mould, set of three pans each	2013	50	Rs 30,000	CAZRI, Jodhpur

(ii) Works

S. No.	Particulars of the Work, Name and Address of Agency Awarded the Work	Year of Work Done	Quantity (Nos.)	Total Cost (`Rs.)	Responsible Partner
1	Renovation of Silvi-cultural and Agroforestry Lab in order to make a separate standard room for *P. juliflora* products and required instruments. Adjoining two sitting rooms. Site of construction – CAZRI, Silva & Agroforestry Lab. Year 2010-11.	2011-12	84.61 m^2 ***Capacity***	4,94,573.00	CAZRI, Jodhpur

(iii) Livestock: NA

S. No.	Details of Livestock (Breed, etc.)	Year of Procurement/Production	Nos.	Total Cost (`)	Responsible Partner

(iv) Revenue Generated: NA

S. No.	Source of Revenue	Year	Total amount (`)	Responsible Partner

20. Awards and Recognitions (See Annex.5)

S. No.	Name, Designation, Address of the Person	Award/ Recognition (with Date)	Institution/ Society Facilitating (Name & Address)	Responsible Partner
1	Dr. S. Ayyappan, Sectory, DARE and DG, ICAR, and Dr. Bangali Baboo, then ND, NAIP	Certificate of Appreciation 16th November, 2012	NAIP, KAB-II, PUSA, New Delhi	• CAZRI, Jodhpur, • National Food Product (India), Jodhpur • DECO, Jodhpur

21. Steps undertaken for post NAIP sustainability

- Voluntary partner Transtech Green Energy Ltd. Chitalwana , Sanchore, Jalore has assured us that unit will look after the pod collection, grading and transportation work in target villages. Exchange of dialogues in this context are on between Transtech Green Energy Ltd. and Amrit Agro Industry, Jodhpur. We hope the project activities will not only continue but also spread out horizontally.
- The rich and influential farmers organized in the present sub-project have been very strong. Because economic gains of these groups are linked with pods collection and selling process, therefore this farmers- cattle feed industry chain will sustain after the NAIP is closed.
- We have built capacity of farmers groups in our target villages to the extent that they can at least process *P. juliflora* pod based animal feed in house hold level. In fact some farmers who owned a thresher are processing same feed for their own use. We are still in the process to motivate them to process this feed in small scale and sell it in surrounding villages. This is the most important steps under taken for post NAIP sustainability.

22. Possible future line of work

- We have received the report of acute and chronic toxicity analysis from NIN, Hyderabad. Both the report indicated that *P. juliflora* pod flour is safe for human consumption. Many small industrial units are ready for processing Instant Juli coffee. We do hope that in future this will be available in market as a coffee substitute. Therefore, the future line of work should focus on various kind of human food product processing.
- As *P. juliflora* thickets are available in hot arid and semi-arid region in abundance however, at the moment such huge biomass available is utilized only for heating and cooking energy needs of about 70 % rural households in arid and semi-arid region. In recent time many small biomass based electric power projects (10 – 25 MW) are being established. The huge availability of *P. juliflora* biomass is a very good propositions for running such power generation units 24 hrs x 365 days. Therefore, the future line of work should also focus on management of *P. juliflora* thickets for more and sustainable availability of above ground biomass and as well as higher pod production. Our R&D in present NAIP sub-project clearly indicated that managed plantation yield higher quantum of pods.

23. Personnel

(Staff of Lead Centre & Partner-wise, their Name, Designation, Discipline and Duration)

Lead Centre, CAZRI, Jodhpur	**From – To (DD/MM/YYYY)**
Research Management (CL)	
1. Dr. K. P.R. Vittal, Director	2008 – 16th August, 2009
2. Dr. N. V. Patil, Director	17th Aug., 2009 - 19th Feb., 2010
3. Dr. M. M. Roy, Director	20th Feb. - March, 2014
Scientific	
4. Dr. L. N. Harsh, PS (Forestry),CPI	2008- 31st August, 2010
5. Dr. J. C. Tewari, PS (Forestry), CPI	1st September- March, 2014
6. Dr. H. C. Bohra, PS (Animal Nutrition), Co- PI	2008- December, 2011
7. Dr. B. L. Gajja, PS (Agril. Eco.), Co-PI	2008- 31st July, 2012
8. Dr. H. A. Khan, PS (Org. Chemistry), Co-PI	2008- December, 2013
9. Dr. (Mrs.) Pratibha Tewari, PS (Foods & Nutrition), Co-PI	2008- March, 2014
10. Dr. B. K. Mathur, PS (Animal Nutrition), Co- PI	2008- March, 2014
11. Dr. P. R. Meghwal PS (Horticulture), Co-PI	2008- December, 2011
12. Dr. M. Azam, PS (Org. Chemistry), Co-PI	
13. Dr. (Mrs) Rajwant K. Kalia, PS (Agroforestry) Co-PI	1st March, 2013- March, 2014
14. Dr. P. Rathakrishnan, Se. Scientist (Forestry), Co-PI	31st Dec. 2010- March, 2014
15. Dr. A. V. S. Sirohi, Sr. Scientist (LPM), Co-PI	2013- March, 2014
16. Dr. H. L. Kushwaha, Scientist (Agril. Engg.), Co-PI	2008- 29th Dec., 2010
Opted Scientist from CAZRI, RRS, Bhuj.	
Dr. Devi Dayal , Dr. M Shamsudheen, Dr.S.L. Meena, Dr. Bhagirath Ram	
Technical	
17. Mr. G. L. Meena	2008- 28th Feb., 2010
18. Mr. Prahlad Singh (TO	2008- March, 2014
19. Mr. Naveen Singh (TA)	2008- March, 2014
Contractual	
20. Mr. Anil Sharma, Office Asst.	17th Dec.2008- March, 2014
21. Mrs. Seena Research Associate	1st January, 2009- 30th April, 2011
22. Mr. Yogendra Singh, Sr. Research Fellow	5th March, 2009- 16th Dec., 2013
23. Mr. Man Mohan Singh, Sr. Research Fellow	27th March, 2010- 31st March, 2012
24. Mr. Dinesh Prajapat, Sr. Research Fellow	6th March, 2009- 10th Aug., 2009
Partner NGO	
25. Dr. Shyam Lal Harsh, DECO, Jodhpur, CCPI	2008- 31st March, 2010
Industrial Partner	
26. Mr. Prem Raj Parakh, National Food Product 27. (India), Jodhpur, CCPI	2008- March, 2014

24. Governance, management, implementation and coordination

A. Composition of the various committees (CIC, CAC, CMU, etc.)

S. No.	Committee Name	Chairman (From-To)	Members (From-To)
1.	**CIC**	Dr. K. P.R. Vittal, Director (2008 – 16th August, 2009)	Dr. Suresh Kumar, HD-II, CAZRI, Jodhpur (2008- March, 2014)
		Dr. N. V. Patil, Director (17th Aug., 2009 - 19th Feb., 2010)	Dr. Shyal Lal Harsh, DECO, Jodhpur (2008- 31st March, 2010)
		Dr. M. M. Roy, Director (20th Feb. - March, 2014)	Mr. Prem Raj Parakh, National Food Product (India), Jodhpur (2008- March, 2014)
2.	**CAC**	Dr. K. R. Solanki, Ex ADG (AF & Agronomy) (2008 – March, 2014)	Dr. Madhu Goyal, Dean, College of Home Science, RAU, Bikaner (2008- March, 2014)
			Ms. Mamta Devi, W/o Anna Ram Van Surakshya Samiti, Village: Khan Pur, District- Jalore (Progressive Woman Farmer) (2008- 12th March, 2011)
			Shri. Mangala Ram Rao, Village, Kothida, District- Jalore (Progressive Farmer) (2008- 12th March, 2011)
			Shri Jaikishan Vishnoi, Village: Lal Pura, Chitalwana, Sanchore, District - Jalore (Progressive Farmer) (13th March, 2011- March, 2014) **Contd…**
			Shri Girdhari Lal Nain, Village: Lal Pura, Chitalwana, Sanchore, District - Jalore (Progressive Farmer) (13th March, 2011- March, 2014)
3.	**CMU**		
		Dr. K. P.R. Vittal, Director (2008 – 16th August, 2009)	Dr. T. K. Bhati PS (Agronomy) (2008 – 31st December, 2013)
		Dr. N. V. Patil, Director (17th Aug., 2009 - 19th Feb., 2010)	Dr. Suresh Kumar, HD-II, CAZRI, Jodhpur (2008- March, 2014)
		Dr. M. M. Roy, Director (20th Feb. - March, 2014)	Dr. A. K. Pate,l PS (LPM) and now Head , ARC of CSWRI, Bikaner (2008-2013) **Contd…**

			Dr. Shyal Lal Harsh, DECO, Jodhpur (2008- 31st March, 2010)
			Mr. Prem Raj Parakh, National Food Product (India), Jodhpur (2008- March, 2014)

B. List of Meetings organized (CIC, CAC, CMU, etc.)

S. No.	Details of the meeting	Date	Place & Address (Where meeting was organized)
1.	**CIC**		
	1st	5th January, 2009	CAZRI, Jodhpur
	2nd	27th July, 2009	CAZRI, Jodhpur
	3rd	7th July, 2010	CAZRI, Jodhpur
	4th	28th January, 2011	CAZRI, Jodhpur
	5th	9th December, 2011	CAZRI, Jodhpur
	6th	13th September, 2012	CAZRI, Jodhpur
	7th	25th February, 2013	CAZRI, RRS, Kukma, Bhuj
2.	**CAC**		
	1st	6th January, 2009	CAZRI, Jodhpur
	2nd	28th July, 2009	CAZRI, Jodhpur
	3rd	8th July, 2010	CAZRI, Jodhpur
	4th	12th December, 2011	CAZRI, Jodhpur
	5th	14th September,2012	CAZRI, Jodhpur
	6th	26th February, 2013	CAZRI, RRS, Kukma, Bhuj
	7th	31st March, 2014 (Terminal)	CAZRI, Jodhpur
3.	**CMU***		
	1st	24th June, 2009	CAZRI, Jodhpur
	2nd	26th August, 2010	CAZRI, Jodhpur
	3rd	18th October, 2011	CAZRI, Jodhpur
	4th	1st March, 2012	CAZRI, Jodhpur
	5th	8th May, 2013	CAZRI, Jodhpur

*****CMU members used to visit target villages, processing facilities, experimental field at the institute, laboratory, etc., off and on and gave advice time to time as per needs. Therefore, we did not write proceedings of such visits. In general, CMU was quite active.*

Part-III: Budget and its Utilization

STATEMENT OF EXPENDITURE (Final)

(Period from Sept. 1, 2008 to Oct. 2013)

(Sept. 1, 2008 ; Launched of 6th Jan. 2009) (31st March, 2014)

Sanction Letter No. F. NO. 1(5) 2007- NAIP, Dated July 31st, 2008

Total Sub-project Cost 194.04 lacs (CAZRI- 176.286 lacs; DECO- 7.83 lacs; NFP- 15.71 lacs)

Sanctioned/Revised Sub-project cost *(if applicable)* **Rs. 199.79 lacs (CAZRI- 176.286 lacs; DECO- 7.84 lacs; NFP- 15.71 lacs)**

Date of Commencement of Sub-project Sept. 1, 2008

Duration: From 15th Aug. 2008to 31st March, 2014 (DD/MM/YYYY)

Funds Received in each year

I Year `Rs. 56,23,500; II Year `Rs. 11,19,576; III Year `Rs. 52,33,594

IV Year Rs. 2, 10, 058; V Year Rs. 18,44,481; VI Year Rs. 22,74,500

Bank Interest received on fund *(if any)* **` NA**

Total amount received ` Rs. 1,63,05,709

Total expenditure `Rs. 1,60,72,979

Expenditure Head-wise: CAZRI, Jodhpur

Sanctioned Heads	**Funds Allocated (*)**	**Funds Released**			**Expenditure Incurred**		
		1st Year	2nd Year	3rd Year	**date**1st Year	**funds**2nd Year	3rd Year
A. Recurring Contingencies							
(1) TA	8.50				30435	91564	76850
(2) Workshops	16.00				-	-	207496
(3) Contractual Services/RA/SRF	25.88				39100	511332	882369
(4) Operational Cost	62.75				253041	243625	2926312
Sub-Total of A (1-4)	131.13				322576	846521	4093027
B. HRD Component							
(5) Training	4.00				-	-	-
(6) Consultancy	-				-	-	-
Sub-Total of B (5-6)	4.00				-	-	-
C. Non-Recurring							
(7) Equipment	41.05				119799	1583770	822136
(8) Furniture	1.00					17375	36759
(9) Works (new renovation)	5.00					494573	-
(10) Others (Animals, Books, etc.)	1.00					-	72498
Sub-Total of C (7-10)	48.05				442375	2942239	9313393
D. Institutional Charges*	11.106				-	-	-
Grand Total (A+B+C+D)	**176.286**	**5623500**	**1119576**	**5233594**	**442375**	**2942239**	**5024420**

* Institutional charges will be 10% of the recurring contingencies for the Lead Consortium and 5% for Consortia Partners.

Sanctioned Heads	Funds Allocated (*)	Funds Released			Expenditure Incurred			Total Expenditure	Balance as on date	Requirement of additional funds	Remarks
		4st Year	5nd Year	6rd Year	4st Year	5nd Year	6rd Year				
A. Recurring Contingencies											
(1) TA	8.50					97845	**139129**				
(2) Workshops	16.00					276038	-				
(3) Contractual Services/RA/SRF	25.88					**168082**	**922620**				
(4) Operational Cost	62.75					731295	**541522**				
Sub-Total of A (1-4)	**131.13**					**1273260**	**1603271**				
B. HRD Component											
(5) Training	4.00					-	-				
(6) Consultancy	-					-	-				
Sub-Total of B (5-6)	**4.00**					-	-				
C. Non-Recurring											
(7) Equipment	41.05			1108000			**1195635**				
(8) Furniture	1.00										
(9) Works (new renovation)	5.00										
(10) Others (Animals, Books, etc.)	1.00										
Sub-Total of C (7-10)	**48.05**					**1273260**	**1195635**				
D. Institutional Charges*	11.106					3093	**126691**				
Grand Total (A+B+C+D)	**176.286**	**210058**	**1844481**	**2274500**	**1783101**	**1276353**	**2925597**	**16072979****	**232730**		

* Institutional charges will be 10% of the recurring contingencies for the Lead Consortium and 5% for Consortia Partners.

** Rs. 1678894/- refunded to PIU- NAIP, in financial year 2011-12

Name & Signature of CPI :

Date: 22/7/14

J.C. Tewari, Ph.D.
CPI, NAIP Project
on Prosopis juliflora
Code : 2101 -2103
Central Arid Zone Research
Institute, Jodhpur

P. K. Tiwari

Name & Signature of Competent Financial authority:

Date:

वित्त एवं लेखा अधिकारी
Finance & Accounts Officer
काजरी, जोधपुर
C.A.Z.R.I., Jodhpur

Signature, name and designation of Consortia Leader

Date:

Dr. M. M. Roy

निदेशक / Director
केन्द्रीय शुष्क क्षेत्र अनुसंधान संस्थान, जोधपुर
Central Arid Zone Research Institute, Jodhpur
Jodhpur- 342003, Rajasthan

PART-IV: DECLARATION

This is to certify that the final report of the Sub-project has been submitted in full consultation with the consortium partners in accordance with the approved objectives and technical programme and the relevant records, note books; materials are available for the same.

Place:_____

Date:_____ Signature of Consortium Principal Investigator

Signature & Date
Consortium Co-Principal Investigator
Desert Environmental Conservation Association (DECO), Jodhpur (NGO

Signature & Date
Consortium Co-Principal Investigator
Nation Food Products (India) Jodhpur
(Industrial Partner)

Comments & Signature of Consortium Leader

Date:

Pro-forma 1(a)

1. **Title of the Sub-project:** Value chain on value added products derived from *Prosopis juliflora*
2. **Name of CPI/CCPI**: Dr. J. C. Tewari, Principal Scientist (Forestry)
3. **Title of the Technology**: ***Prosopis juliflora* pod based feed block**
4. **Information on existing farming systems, practices, productivity levels and income in the target area**: Present project is based on utilization of extensively distributed tree species *P. juliflora,* which are found on field boundaries, wastelands, village commons and sometimes also on farmers' fields. The farming system in the area is mixed crop-livestock based and practiced under rain fed situations.
5. **Key intervention(s) introduced**: Collection, grading and threshing the pods. The complete feed block production technology involved, drying and milling of *Prosopis juliflora* pods, using hammer mill and passed through coarse sieve (Coarse); further milled and passed through fine sieve (fines). Separated milled products were mixed with other feed ingredients and compressed to produce the complete feed block for feeding the nutritionally deprived livestock. The Full Circle Hammer Mill (FCHM) driven by 7.5 hp electric motor, basically developed for milling of concentrate feeds like, cereal and leguminous seeds, and oil seed cakes were used for coarse- and fine-milling of the sun dried *P. juliflora* pods. Two types of products obtained by FCHM milling, only fine portion was used for production of complete feed blocks using hydraulic fodder block making machine.
6. **Results (status of dissemination/ commercialization; and, extent of adoption and success)**: Experimentation in the institute as well as on farm level demonstrated that *Prosopis juliflora* pod based feed block has very high potential as a substitute of fodder concentrate during lien period of fodder availability. The details have been given in research achievement and summary part of present report.
7. **Brief description of technology for release**: *P. juliflora* feed blocks were prepared with dried *P. juliflora* pods (73.5%), molasses (4.9%), urea (2%), dolomite (1.5%), guar korma (8.2%), tumba seed cake (6.9%), vitamin added mineral mixture (1.5%) and salt (1.5%). These ingredients were mixed in feed mixture and blocks (2 kg each) were prepared with fodder block making machine.
8. **Expected outcome/impact of the technology:**
   (8.1) Expected Increase in Area, Production and Net Income: It is a simple and appropriate technologies for production of animal feed products using *P. juliflora* milled products which will help to develop economical ration and augment livestock productivity in the drought prone areas. These products are not only nutritionally superior, but also cheaper over the standard formulation livestock feed-products.
   (8.2) Others: **NA**
9. **Whether findings have been published? If so, give the citation and enclose copy of the publication:** CAZRI publications.

10. **Any other information:**
    Economics and Business Potential

Prosopis juliflora pod powder is major ingredient in the blocks, which is available only @ Rs. 6/kg and inclusion *Prosopis juliflora* pod powder in such a large quantity make it possible to use other costly ingredients in very small quantity. This resulted in lowering of the cost of this complete feed block without compromising the nutritive value of the product. A 2 kg block is being sold by the CAZRI through ATIC @ Rs. 45/ block. This is much cheaper in comparison of the feed blocks available in market. The major advantage with *P. juliflora* pod based complete feed block is their long duration storage ability and easy transportation. The potential taker of the technology involves all *Gaushalas* across the Rajasthan where state Government provide funding on per animal basis and the other potential clients would be animal feed industry, dairy cooperatives, and private dairies in contract with dairy farmers for milk collection.

Impact of the Technology

At the moment the product is being sold by ATIC of CAZRI, however we are in the process to take technology to the door steps of the farmers. To produce these complete feed blocks a simple press and moulds are required. With very small investments farmers can produce these block on their door steps and can store the same for longer period. The major impact of the technology is that farmers are coming to purchase these blocks especially, for small ruminants as one block is sufficient for a goat or sheep for three days. Increased body weight and milk yields of small ruminants by using these blocks have attracted the attention of farmers for using these block in large scale.

Processing of *Prosopis juliflora* pod based feed block

***Prosopis juliflora* pod based feed block ready for marketing through ATIC, CAZRI**

Pro-forma 1(b)

1. **Title of the Sub-project**: Value chain on value added products derived from *Prosopis juliflora*
2. **Name of CPI/CCPI**: Dr. J. C. Tewari, Principal Scientist (Forestry)
3. **Title of the technology**: **Multi-nutrient feed Block**
4. **Information on existing farming systems, practices, productivity levels and income in the target area:** The farming system in the area is mixed crop-livestock based and practiced under rain fed situations. On an average income per household in the target area was Rs. 4000/-. Present project is based on utilization of extensively distributed tree species *P. juliflora,* which are found on field boundaries, wastelands, village commons and sometimes also on farmers' fields. Pods of the species are very nutritious and on an averages from a better tree stand of the species 1-1.5 t pods/ha could be harvested. However, in general the growth of tree is found in form of weedy thickets and in such thickets the production of pods ranged from 0.25 to 0.5 t/ha.
5. **Key intervention(s) introduced**: Collection, grading and threshing the pods.
6. **Results (Status of dissemination/ commercialization; and, extent of adoption and success):** Multi-nutrient feed blocks are processed and produced in animal feed unit of CAZRI and are being sold through ATIC regularly. Efforts are being made to market these blocks through industrial partners.
7. **Brief description of technology released**: Guar seed meal is commonly used in multi-nutrient feed blocks. *P. juliflora* seed meal contained 2.77% minerals, 8.35% ether extracts, 44% crude protein and 44.9% total carbohydrates. These values are comparable with seed meal of guar. Therefore, multi-nutrient feed blocks were prepared by replacing guar meal by *P. juliflora* seed meal. Other contents of this block are tumba (*Citrullus colocynthis*) seed cake, molasses, urea, common salt, dolomite and vitamin-mineral mixture. Nutritional composition of multi-nutrient feed block is as under:

Chemical composition (% on DM basis) of multi-nutrient comprised of *P. juliflora* milled products

Milled product	Preformed water*	Ash	Organic matter	Crude protein	Ether extrac-tives	Total Carbo-hydrates	Gross energy, kcal
Multinutrient block	8.1	9.9	92.4	22.3	2.0	67.9	415

*as such basis.

8. **Expected Outcome/Impact of the Technology**:
   (8.1) ***Expected Increase in Area, Production and Net Income***: This product reduced the cost of multi-nutrient feed block in one hand and added to its nutritive value on the other. In these feed blocks milled products of *P. juliflora* pod viz., epicarp, endocarp and mesocarp could be used individually and as well as in combination. The feed blocks are liked by the farmers under FPARP and NRAA

mega livestock centric programmes. The farmer groups have been motivated to market these blocks in the villages. Popularity of these feed blocks among villagers are increasing day by day.

(8.2) ***Others***: Cost effective, easy to prepare, nutritious to the extent of standard feed block and easy to transport.

9. **Whether findings have been published? If so, give the citation and enclose copy of the publication.** Yes, CAZRI publication.
10. **Any other information**: NA

Prosopis juliflora **pod based muitly-nutrient feed block**

Pro-forma 1(c)

1. **Title of the Sub-project:** Value chain on value added products derived from *Prosopis juliflora*
2. **Name of CPI/CCPI:** Dr. J. C. Tewari, Principal Scientist (Forestry)
3. **Title of the technology**: **Instant Juli coffee**
4. **Information on existing farming systems, practices, productivity levels and income in the target area**: The existing farming system in the target area is mixed crop-livestock based. Subsistence rain fed farming is practiced, productivity levels are low as below normal rainfall and drought are not uncommon in the area. Average income of household in the area is Rs. 4000/- as per our base line survey.
5. **Key intervention(s) introduced**: *Prosopis juliflora* pod collection, grading and threshing. Imparted skill trainings to farmers to accomplish the above said tasks.
6. **Results (Status of dissemination/ commercialization; and, extent of adoption and success)**: Coffee substitute prepared from *P. juliflora* pods is commercial product and marketed in its native range (Peru, Argentina, Brazil and some other Latin American countries). Often it is blended with conventional coffee to a particular proportion, resulting in price reduction and caffeine content reduction with not much difference in smell and taste. We started our work taking all these facts in view while developing a blended coffee substitute. With repeated trials and errors, ultimately we perfected the production process of *P. juliflora* coffee. This coffee has been given brand name '***Instant Juli Coffee'***. The technology has been transferred to industrial partner. As it is a human food product therefore, before large scale commercial production and marketing, it was mandatory to test its toxicity and get clearance from competent organization. The task has been outsourced to NIN, Hyderabad to test its acute and chronic toxicity. The reports have been received and *P. juliflora* pod flour have been found safe for human consumption.
7. **Brief description of technology for release:**

- Under NAIP sub-Project " Value chain of value added products derived from *Prosopis juliflora* " technology for processing *P. juliflora* pod based blended instant coffee " Juli coffee" was developed, refined and perfected. Perfected technological innovation in brief is as under: Ripe pods of *P. juliflora* were thrashed in a specially designed plot thresher and epicarp+ mesocarp and endocarp is separated. The epicarp+ mesocarp mixture is sieved by 20 mesh fine sieve.
- By threshing and sieving 20 kg pods, approximately 5kg fine mesocarp is obtained which is used for processing "Juli coffee". This fine mesocarp powder is roasted at 250^{o} C for half an hour in a pre-heated oven (150 ^{o} C) with intermittent mixing. The powder thus obtained is matched with a score card develop to determine end point. Roasted powder thus obtained is blended with 20% original roasted coffee powder. After mixing original roasted coffee powder, 10 % chicory powder is mixed in this mixture. Thus, 70%: 20%: 10% combination of *P. juliflora* roasted mesocarp powder,

original coffee powder and chicory powder is obtained, which give taste, colour and aroma of normal instant coffee.

- For obtaining best and highly soluble "Juli coffee" the mixture obtained as above is dissolved in water @ of 100g mixture in 200 ml water and filtered. In this way 90 g "Juli coffee" powder is obtained which is freeze dried for 9-10 hours. After completing this process 70g best quality "Juli coffee "is obtained. This instant "Juli coffee "made in to desire marketing packing.

8. **Expected outcome/impact of the technology:**
   (8.1) ***Expected increase in area, production and net income***: Once the Instant Juli Coffee is commercially produced and marketed, it will increase the demand of *P. juliflora* pods tremendously which will ultimately benefit to the farmers of entire arid western Rajasthan because the region is major domain of the species.
   (8.2) ***Others:*** New food in human food basket.
9. **Whether findings have been published? If so, give the citation and enclose copy of the publication**. We did not publish the findings even in Institute publication as per understanding between our consortium (CAZRI) and NIN, Hyderabad. It was agreed that research papers, other publication, etc., will be done jointly by NAIP, sub-project consortium and NIN, Hyderabad.
10. **Any other information**, ***cost effectiveness*****:** Analysis of current market trends of instant coffee brands indicated that on an average they cost Rs. 108/ 100 g. We calculated the cost of complete processing of "Instant Juli coffee" and end product to super markets cost. At the present rate of *P. juliflora* raw pods, conventional coffee bean and chicory powder, the completely processed and packed " Instant Juli coffee" will cost only Rs. 45/ 100g. Our cost estimate are based by taking the cost of raw material to much higher rate in compression to present actual rates.

Instant Juli coffee

Pro-forma 1(d)

Details of Technologies/ Innovations Commercialized

(Page limit: 3 pages/ technology)

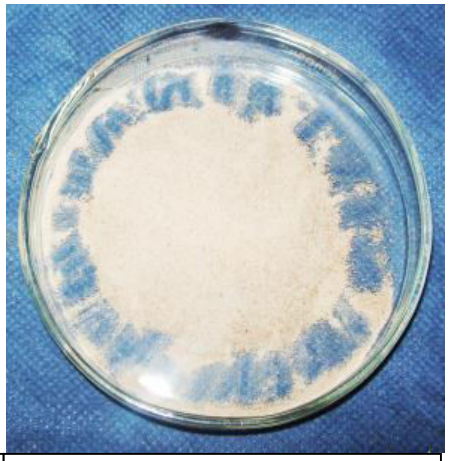
1. **Title of the sub-project**: Value chain and value added product derived from *Prosopis jiliflora*
2. **Name of CPI/CCPI**: Dr. J.C. Tewari (C-PI)
3. **Title of the technology**: ***Prosopis juliflora* seed gum – An alternatives source of guar gum**
4. **Information on existing farming systems, practices, productivity levels and income in the target area**: The existing farming system in the target area is mixed crop-livestock based. Subsistence rain fed farming is practiced, productivity levels are low as below normal rainfall and drought are not uncommon in the area
5. **Key intervention(s) introduced**: *Prosopis juliflora* pod collection, grading and threshing. There are various methods for the extraction of different seed gums. Method for *Prosopis* seed gum extraction has been standardized.
6. **Results (status of dissemination/commercialization; and, extent of adoption and success): NA**
7. **Brief description of technology for release**: *Prosopis juliflora* seeds were mechanically separated and ground to a coarse particle sized flour in an electronic mill. Ground seeds were submitted to lipid extraction with toluene:ethyl alcohol (2:1) mixture in a Soxhlet, for 24 hrs. Defatted ground seeds were dispersed in water (1:20) and boiled for 10 minutes for enzyme inactivation. The system was cooled and allowed to rest for 24 hrs at room temperature. The crude mixture, containing pieces of hull, germ and the galactomamman solution, was filtered and centrifuged at 6500 rpm. The clarified supernatant was retained and mixed with ethyl alcohol (1.5 parts of alcohol for 1 part of supernatant) to obtain a mucilaginous precipitate. It was filtered, dried at 40^0C and milled to produce powdered gum. The yield was 21%.
8. **Expected outcome/impact of the technology:**

   (8.1) ***Expected increase in area, production and net income***

   Prosopis juliflora seed is composed of episperm (20%), endosperm (32%) and cotyledon (48%). Endosperm and cotyledon are the source of gum (about 30% of the seed weight) and protein (21% of the seed weight), respectively. The endosperm gum was identified as a galactomannan with a Gal: Man (1:1.82) and has a close similarity to guar gum, which has many industrial applications in food, paper, textile, petroleum, pharmaceuticals and cosmetics. Extraction from ground seeds in neutral medium was found to be simple and most suitable. The gum content isolated by this method was 21%, and protein content in the residue was 42%. If the technology is accepted and utilized by guar gum processing industries, it has the potential go side by side the guar gum.

   (8.2) ***Others: NA***
9. **Whether findings have been published? If so, give the citation and enclose copy of the publication**: Technical folder published from CAZRI, Jodhpur

10. **Any other information:** NA

		
P. juliflora Seeds	*P. juliflora* Seed powder	*P. juliflora* edible seed gum

Pro-forma1 (e)

1. **Title of the sub-project: Value chain on value added products derived from *Prosopis juliflora***
2. **Name of CPI/CCPI**: Dr. J. C. Tewari, Principal Scientist (Forestry)
3. **Title of the technology**: **Identification of the antioxidant compound from *Prosopis juliflora* wood**
4. **Information on existing farming systems, practices, productivity levels and income in the target area**: The existing farming system in the target area is mixed crop-livestock based. Subsistence rain fed farming is practiced, productivity levels are low as below normal rainfall and drought are not uncommon in the area.
5. **Key intervention(s) introduced**: *Prosopis juliflora* heartwood and sapwood were separated and collected.
6. **Results (status of dissemination/commercialization; and, extent of adoption and success) : NA**
7. **Brief description of technology for release**: *Prosopis juliflora* heartwood and sapwood were separated and collected. Air dried wood materials were ground to fine powder and dried at 60^{o} C before extraction. Powdered wood materials were extracted with organic solvent using soxhlet extractor for 25 hours. After extraction, the solvent was evaporated under reduced pressure and the crude extract dried under vacuum. The heartwood and sapwood yielded 6-8% and 1-2% (-)-mesquitol, respectively.

8. **Expected outcome/Impact of the technology:**
   (8.1) ***Expected increase in area, production and net income***: The antioxidant compound which is present in concentrated form (6-8%) in the heart wood of *P. juliflora,* has been identified as (-)-mesquitol ($C_{15}H_{14}O_6$). It has flavonol structure assigned as 2, 3-trans-3', 4', 7, 8-tetrahydroxyflavan-3-ol and has close similarity to (+) - Catechin and (-)-Epicatechin. It is brown to pale yellow in colour having melting point 81-83^{0}C. Its silica gel TLC has Rf value of 0.45 with ethyl acetate. (-)-Mesquitol has been compared with existing pharmacologically / therapeutically accepted antioxidant probucol and -tocopherol. It is found that (-)-mesquitol is better than the above mentioned reference drugs.
   (8.2) ***Others***: NA
9. **Whether findings have been published? If so, give the citation and enclose copy of the publication**: Technical folder published by CAZRI, Jodhpur
10. **Any other information**. NA

Pro-forma 1(f)

1. **Title of the sub-project**: Value chain on value added products derived from *Prosopis juliflora*
2. **Name of CPI/CCPI**: Dr. J. C. Tewari, Principal Scientist (Forestry)
3. **Title of the technology**: **Isolation of edible protein from *Prosopis juliflora* seed**
4. **Information on existing farming systems, practices, productivity levels and income in the target area**: The existing farming system in the target area is mixed crop-livestock based. Subsistence rain fed farming is practiced, productivity levels are low as below normal rainfall and drought are not uncommon in the area.
5. **Key intervention(s) introduced**: Husk, cotyledon, gum portion of *P. juliflora* seeds were manually separated and analyzed for total protein, dry matter and moisture content and compared with those of guar seeds.
6. **Results (status of dissemination/commercialization; and, extent of adoption and success):** The technology has been successfully perfected (Innovative process technology).
7. **Brief description of technology for release**: Optimum conditions for protein extractability was established by considering solid: solvent ratio, S:L (Exp. I), Extraction time (Exp. II), type of solvent (Exp. III), pH (Exp. IV) as shown under:

Extraction conditions of *P. juliflora* protein

Parameter	Parameter			
	Exp. I	Exp. II	Exp. III	Exp. IV
Parameter tested	Solid: Solvent – 1:20 to 1:100	Time: 0.5 h to 6h	a) Distilled water b)NaCl molar solution c) $NaSO_4$ molar solution	Ph: 2.5 to 12
Parameter kept constant	i)Time: 2h ii) Solvent: Distilled water iii) pH as obtained from aqueous solution	i)S:L – 1:50 ii)Solvent: Distilled water iii) pH as obtained from aqueous solution	i)Time: 3h ii)S:L – 1:50 iii)pH as obtained from aqueous solution	i)Time: 3h ii)S:L – 1:50 iii) Solvent: Distilled water

Protein extractability of *p. juliflora* seeds is greatly affected by above conditions. Extractable protein increased from 19.8 to 26.4 mg/ml when solid to solvent ratio increased from 1:20 to 1:50 .Solid to solvent ratio in the range 1:50 to 1:100 did not give significantly different extractable protein. Maximum extractable protein was obtained at 3 hours time. After 3 hours there is decreasing trend in protein content. Isoelectric pint was observed at pH 5.5. Extractability was maximum (43.2 mg/ml) at pH 2.5 which decreases to 14.5 mg/ml at pH 5.5. Protein extractability is higher in aqueous sodium sulfate solution and it was maximum when the molar concentration of the salt was 0.1M.

8. **Expected outcome/impact of the technology**:
   (8.1) ***Expected increase in area, production and net income***: Protein content is better in *juliflora* seeds than in guar. The portion Cotyledon of *P. juliflora* seed is the richest source of protein (64 -71%).
   (8.2) ***Others***: NA
9. **Whether findings have been published? If so, give the citation and enclose copy of the publication**: No
10. **Any other information**: No

Pro-forma 1(g)

1. **Title of the Sub-project:** Value chain on value added product derived from *Prosopis jiliflora*
2. **Name of CPI/CCPI**: Dr. J.C. Tewari (CPI)
3. **Title of technology**: ***Prosopis juliflora* based Juli Syrup and pod based fine flour.**
4 **Information on existing farming systems, practices, productivity levels and income in the target area**: The existing farming system in the target area is mixed crop-livestock based. Subsistence rain fed farming is practiced, productivity levels are low as below normal rainfall and drought are not uncommon in the area.
5 **Key intervention(s) introduced**: Seed portion with endocarp (septa containing seed) separated from the pods, boiling of epicarp and mesocarp, filtration of the solution to remove coarse particle boiling the filtrate to obtain Nutrient rich Juli syrup. Fine flour is obtain as a by product which has great potential in processing confectionary items.
6 **Results (status of dissemination/commercialization; and, extent of adoption and success)**: The products are successfully processed. Innovative process technology
7 **Brief description of technology for release**:

Sound and ripe pods were selected, washed and broken into small pieces. 350 g of pods were boiled in water (1 liter) for two hours followed by filtration using watman filter paper to separate the coarse particles. About 100 ml liquid was obtained from 350g pods. To obtain the syrup, the liquid was boiled until it reached the necessary consistency. This thick liquid was yellowish brown in colour and can be used as a beverage directly or can be mixed with milk and fruit juices. This syrup is widely used in Latin and South American countries.

The residue left after preparing the syrup was used for producing fine flour and fiber. The quantum of fine flour and fiber obtained from 350g pods was 62g and 26g, respectively. The fine flour obtained by this process was suitable for use in confectionary items. The process technology standardized for these products.

8 **Expected outcome/impact of the technology**:

(8.1) ***Expected increase in area, production and net income***: Juli syrup is a nutrient rich sugary concentrate. Its nutritional attributes are as under:

Products	Ash*	Organic Matter*	Crude Protein*	Ether extractives *	Total Carbohydrates*	Gross energy, Kcal/100 g
Juli Syrup	9.25	90.70	12.82	8.00	69.93	438
Fine Flour	2.00	98.00	8.29	10.25	79.46	473
Fine Fiber	2.50	97.50	4.54	8.00	84.96	453

*On dry matter basis

(8.2) ***Others***: NA

9 **Whether findings have been published? If so, give the citation and enclose copy of the publication**: No

10 **Any other information**: No

Fine Pod Flour, Juli Syrup and Fine Pod Fiber

Pro-forma 2

Details of Technologies/ Innovations Commercialized
(Page limit: 3 pages/ technology)

1. **Title of the Sub-project:** Value chain on value added product derived from *Prosopis jiliflora*
2. **Name of CPI/CCPI**: Dr. J.C.Tewari (CPI), CAZRI, Jodhpur/ Mr. Prem Raj Parakh, National Food Product (India), Jodhpur (CCPI)/ *Mr. Mahesh Bohra, Amrit Agro Industry, Jodhpur, voluntary partner*
3. **Title of the technology**: *P. juliflora* pod based concentrate mixture (feed)
4. **Commercialization status with date of licensing MOU**: The technology has been commercialized. In addition to designated industrial partner (National Food Products, (India), Jodhpur), where ***Kajri Pashu Aahar*** is being processed and marketed, a voluntary partner (Amrit Agro Industry, Jodhpur) is processing this concentrate ration in brand name of ***Amrit Pashu Aahar*** on much higher commercial scale. Till date voluntary partner Amrit Agro Industry has generated extra employment to the tune of 5840 man days and that of industrial partner National Food Products (India), Jodhpur 1460 man days. At the moment the production of *P. juliflora* pod based feed is being done by our partners only.
5. **Brief description of intervention/ innovation**: The concentrate was prepared by simply mixing the ground feed ingredients including *Prosopis juliflora* pods (30%) , mustard cake (20%), Guar (*Cyamopsis tetragonaloba*) korma (18%), de-oiled rice bran (30%) and common salt + mineral mixture (2%). *P. juliflora* pod flour is the main constituent of this feed. Whole pods (including seeds) are ground to process the flour as seed contains about 21% protein.
6. **Name and address of the firm which has commercialized it**:
    - National Food Product (India) Jodhpur, Heavy Industrial Area, Jodhpur
    - Amrit Pashu Aahar, Basni Industrial Area, Phase-II, Jodhpur
7. **Area (State(s)/ District (s) covered**: Rajasthan State; District: Jodhpur and Jalore,
8. **Volume/ quantity and approximate sale value**: According to records voluntary partner *Amrit Pashu Aahar,* till date the processing unit has sold the product to the tune of 500 t in the market and earned a revenue of Rs. 57,40,000/- with a net profit gain to the tune of 12,10,000. However, industrial partner who is processing *Kajri Pashu Aahar* sold the product only 100 t and earned total revenue Rs. 11,48,000/- i.e. Rs. 3.83 lacs/ year. The low production in the industrial partner unit was due to the fact that it was primarily meant for human food processing unit and we have provided him the technology to process Instant Juli coffee. It appears that he was not much interested in the production of *P. juliflora* pods based livestock feed.
9. **Benchmark (existing similar product) and consumer acceptance, particularly in case of food products**: No such product was available earlier. According to statement of our partner processor, the acceptance of the product by farmers and livestock keepers was satisfactory. Voluntary partner Amrit Agro Industry Ltd., Jodhpur had

the view that its economics, business potential and impact of technology are in very positive side.

Economics and Business Potential

The conventional cattle feed in the market costs Rs. 600-650/ bag of 50 kg on the basis of demand for a particular brand. If *P. juliflora* whole pod powder is used as a major ingredient Rs. 2.0/kg cost can be reduced without compromising the nutritional value of the feed. *P. juliflora* pod based cattle feed developed under NAIP sub-project " Value chain on value added products derived from *Prosopis juliflora*" costs 75/ 50 kg bag on the basis of fluctuation of prices of other ingredients. Moreover, the nutritional value of *P.juliflora* pod based cattle feed is better than the conventional feed available in the market. The cost can be further reduced if pod collection and storing facilities can be improved up to desired scale.

Impact of the technology

The technology is a lower cost proposition with higher nutritive value. By using the cattle feed based on *P. juliflora* pods increased milk yield by reducing cost of milk production was most important issue addressed by the present NAIP sub-project . As large scale pod volume is required for processing the cattle feed, the pod collection activities coupled with primary value addition (pod thrashing) provided farmers' with extra income. The whole pod is purchased @ Rs. 5.0/kg and that of thrashed pod costed Rs. 6.0/kg. However, in this cost such nutritious ingredient is much cheaper than other ingredients like, guar korma, cotton seed cake, etc. The important attributes this technology are:

- Easily availability of nutritious (concentrate) feed,
- Employment generation at village level.

10. **Status of patenting, If patentable, trademark or any other IPR title, if applicable**: NA
11. **Status of publication and publicity**: Wide publicity in print and electronic media.

***P. juliflora* based cattle feed (*Kajri Pashu Aahar*) production at factory**

Former ND, NAIP inspecting Kajri Pashu Aahar at partner industry

Former ND, NAIP and NC, Com. -IV interacting with media at partner industry

Pro-forma 3

Details on Rural Entrepreneurship. Rural industries developed

Information on Rural Industries

1. Name of Sub-project: Value chain on value added products derived from *Prosopis juliflora*
2. Name of CPI: Dr. J. C. Tewari, Principal Scientist (Forestry)
3. Name of Rural Industry with Address: *Prosopis juliflora* pod collection, grading, storing and primary value addition (PVA) centre, Village-Lalpura, Sanchore, Jalore
4. Contact; Phone and E-mail of rural industry: Shri Jai Kishan Vishnoi, Mobile No. 9571138491
5. Investment (Rs.): NAIP funds : **Nil**
Industry/Entrepreneur: By own small investment
6. Product(s) produced and marketed: Threshed pods of *Prosopis juliflora*
7. Annual Production (kg or litre): 20 t per annum
8. Raw material(s) and quantity used/year (kg or litre): Not applicable
9. Cost of raw material (per kg or litre): -
10. Price of product: only Pods: Rs. 5/kg
:PVA Pods : Rs. 6/kg
11. Type of beneficiaries: Farmers
12. No. of beneficiaries: 250
13. How the industry is beneficial to primary producers: By collection and sale of *Prosopis juliflora* pods.
14. Estimated employment generation/year (person days):360 man days for 90 days in a year
15. CPI to explain whether the industry is approved by FPO/BIS or any other statutory body and how the food safety and quality assurance of end product are being ensured?
NA

Group discussion at Prosopis *juliflora* pod collection, grading and PVA unit at village Lalpura

Pod collected by an individual household for selling it at pod collection unit at village Lalpura

Transportation of pods from pod collection centre to processing unit at Jodhpur

Annex 1

TGPPL

Transtech

GREEN POWER PRIVATE LIMITED

GREEN ENERGY PURE ENERGY

To

The Director

CAZRI

Jodhpur

Sir

We thank you for the assistance provided by NAIP project "Value Chain on Value Aded Products Derived from Prosophis Juliflora". We are working as associate partner in said project. Our unit is generating 12 MW mainly through combustion of Prosophis Juliflora wood. Rural employment generated by this unit is approximate 200 mandays per day.

We wish continuous association in said project.

With best wishes

For Transtech Green Power Pvt. Ltd.

Abhay Khanna

Head Operations

Dated:- 26-02-2011

Dr Tewari 4/3/11 I/c Dir.

निदेशक कार्यालय
OFFICE OF DIRECTOR
क्र. Dy. No. 694
दिनांक/Date 4/3/11

Registered Office : D-28, South Extension, Part 1, New Delhi - 110049

Corporate Office: C-30, Lajpat Marg, C-Scheme, Jaipur - 302 001
Ph.: +91 141 5109888, Fax: +91 141 5109777 / 5109451 • E-mail: transtech@tgpl.in • Website: www.transtechgreen.com

Annex 2

University of Nairobi
College of Agriculture and Veterinary Sciences
PROSOPIS PROJECT

P.O. Box 29053
KANGEMI 00625
NAIROBI, KENYA

TEL: +254 020 631 353
WEBSITE: www.uonbi.ac.ke/colleges/id?=CAVS
EMAIL: rgwahome@uonbi.ac.ke, rgwahome@gmail.com

August 5, 2010

Director-General,
Indian Council for Agricultural Research (ICAR)
Krishi Bhawan,
New Delhi,
India

Dear Sir,

Re: Kenyan Prosopis Delegation study tour to India

The government of Kenya funded the Prosopis Project to develop management and utilization technologies for *Prosopis juliflora*. We had information that the nation of India had developed skills that made the tree profitable to the communities.

Thanks to the generosity of the people of India and no less your own, a delegation of the Kenya government visited the Central Arid Zone Research Institute between 13th and 23rd July 2010. As I hope you are aware, the delegation intended to gain insight on potential uses of *Prosopis juliflora*, which has invaded large tracts of the Kenyan rangelands thus reducing access and availability to livestock grazing.

The Institute gave us an exposure of the massive variety and amount of ongoing research. We were able to visit all the Institute's divisions and were advantaged to the broadening of our minds. We are very grateful for this. Towards our main reason for the visit, we benefited a great deal from the World Bank funded "National Agricultural Innovations Project on *Prosopis juliflora*" headed by Dr J.C. Tewari. Between him and Dr Harsh, they introduced us to the whole juliflora value chain. We wish to acknowledge the many initiatives they have set-up for *juliflora* utilization. We also appreciated how well they worked with scientists in their own division and other divisions.

My Principal wishes me to extend her gratitude to CAZRI's generosity. I also, once gain, wish to thank you for accepting to host us during those ten days.

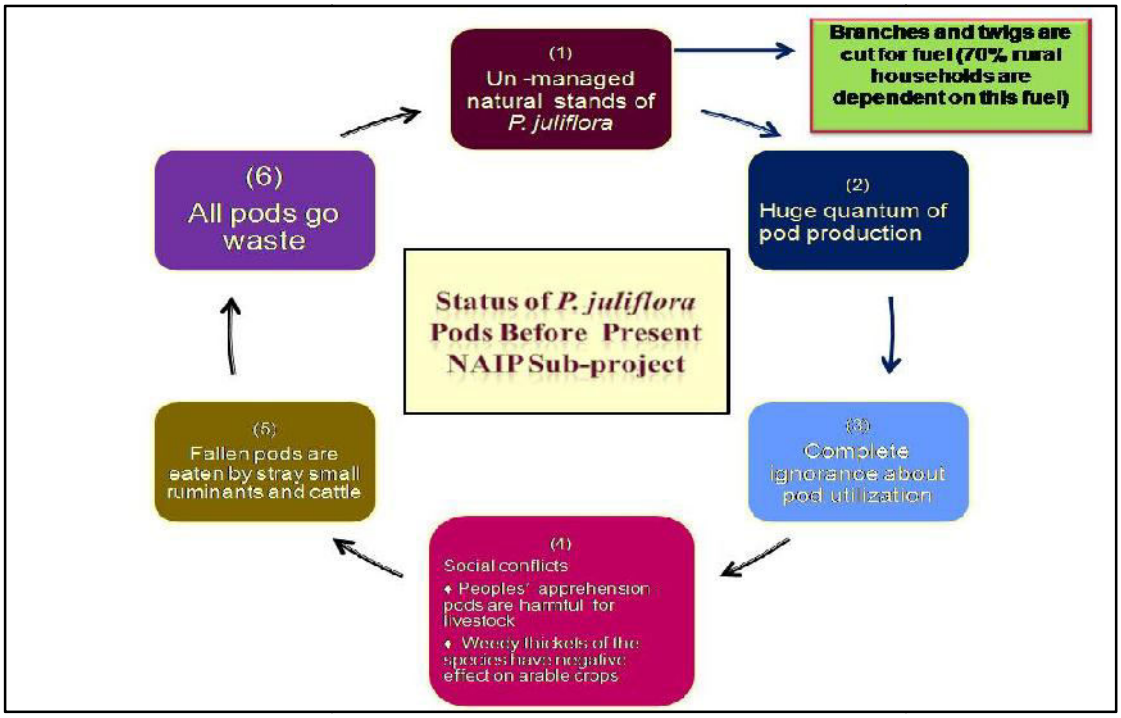
Yours sincerely

Dr Raphael G. Wahome, PhD
Senior Lecturer and Project Leader,
Prosopis Project
University of Nairobi

Annex 3

Value Chain Analysis

In fact, *P. juliflora* pods had no value before interventions are made in present sub-project of NAIP. Though *P. juliflora* has spread over in larger tracts of hot arid and semi –arid regions of the country, which constituted 40% of it's geographically area. *P. juliflora* has become an important topic of discussions and policy in the country during recent years. Invasion of grasslands, protected forests and nature reserves has alarmed ecologists. Invasion of irrigation channels and arable land has affected the agricultural community and commercial farmers have seen their income threatened. However, *P. juliflora* is also playing a vital role in sustaining the livelihoods of the rural poor, including the landless, small farmers and artisans - the least vocal groups of society. These groups support our idea to increase the value of this tree, not eradication as it is the only source of fuel, small round wood and a dry season fodder in form of pods and thus, provides additional livelihood resource to a large section of rural society. Pods of the species are highly nutritious and in its native range they are processed for variety of livestock and human use products. The scenario of pod utilization before implementation of present NAIP sub-project in target sites was as under:



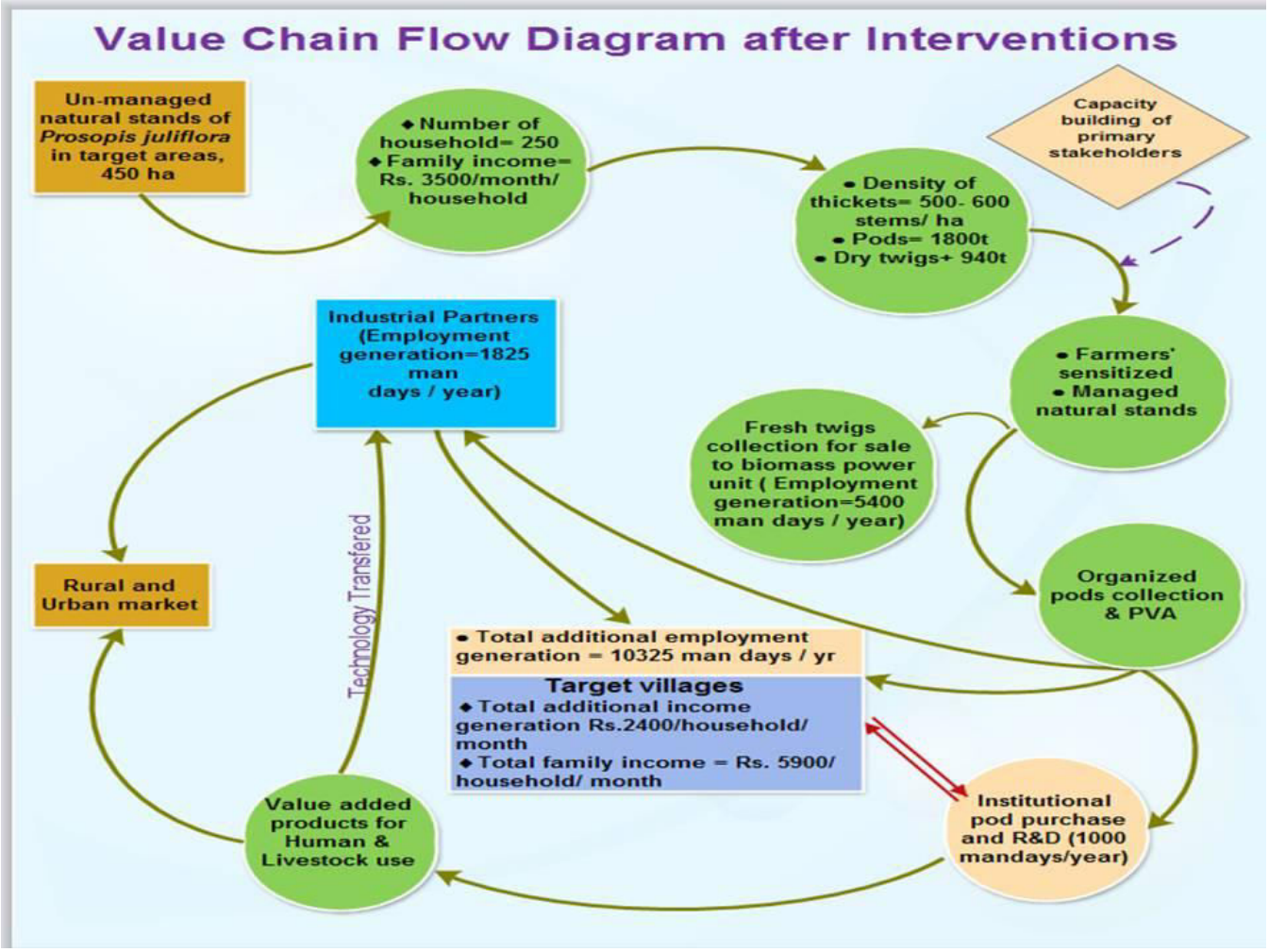
Value Chain for Value Added Products of *P. juliflora* Developed in present NAIP sub-project

Pods of the species are high in sugar and protein, and are rich feed source for livestock and alternative food source for human beings. In its native range from Mexico to Peru, people have developed local economies based on this tree and its products as they use its timber and pods are stored year round for fodder. Pods are also made into flour to process some product like coffee substitute, highly nutritious syrup for family use and local market, and for processing some confectionery items. Using this knowledge with the financial support from NAIP, we developed pod based products for livestock and human consumption. The production technologies for livestock concentrate ration and feed block, and coffee substitute for human use is ready for commercialization. In fact, livestock concentrate is available in local markets by brand name *Amrit Pashu Aahar* and *Kajari Pashu Aahar* processed by Amrit Agro Industry, Jodhpur and National Food Products (India), Jodhpur respectively. Process technologies for multi nutrient feed block, *Prosopis* seed gum, Anti- oxidant "Mesquitol", edible protein, exudate gum, nutritious syrup and fine pod flour for use in confectionery items as a bio-leavening agent has been standardized. All these products are cheaper and easy to process into different commodities for livestock and human use. The developed value chain involved primary stakeholders, entrepreneurs, small scale industrialists, NGOs and research institution.

Simple Economics of Value Chain

Present value chain is operating in 250 household involving four villages in district Jalore, Rajasthan. The primary stakeholder received additional employment to the tune of 4000 man days/ year through pod collection, grading and primary value addition, and selling fresh twigs of *P. juliflora* to biomass energy power plant. These man days provided additional income of Rs. 2400/ household/ month. Thus, on an average, the income of each participating household increased by 68%/ year. Though the man days generated in biomass power generation plant are not directly related to the value chain and therefore, we did not included the earning of farmers' from this activity. As employment generated in selling the twigs and small branches of *P. juliflora* was 5400 man days/ year, it indicated that farmers' earned appreciable amount of income through this activity. Our linkage with biomass power generating unit provided great support to maintain the supply chain of *P. juliflora* pods to processing units at Jodhpur and providing sustainability to project activities. The processors generated employment to the tune of 1825 man days/ year and earned an income of Rs. 6.90 million/ year with a net profit

of Rs. 1.20 million/ year. Thus, total value of present value chain is 9.30 million/ year excluding Rs. 1.5 million/ year earned by the villager through the sale of fresh *P. juliflora* twigs to biomass power generating unit. The value chain flow diagram after interventions is as under:



Annex 4

Different pathways of Prosopis juliflora value chain: A two way table

Sustainability	•Managed plantation stands •Sustainable higher pod production (20-25 kg/ plant)	Horizontal expansion of sweet pod bearing plant types of *Prosopis*	Products development; production and process technologies standardized	Year round availability of raw material for products processing	More livestock feed processing industries are showing interest.	Roping more and more industrial unit to process these products.
Impact	•Increased pod production by 25% •Straight boles of the plants. • Employment: 4000 man days/year	• Four Plantations of such *Prosopis* plant type established • Forest department of Haryana and Punjab also started this activities.	• Livelihood enhancement • Pilot scale production of products for livestock and human consumption	• Processors showed interest for processing *P. juliflora* pod based feed and Instant Juli coffee	• Commercialization of technologies • Availability of products in the market. •Employment 7300 man days/ year.	•Instant Juli coffee availability is expected (coffee substitute) in he market soon.
Outcome	•Managed plantations. •Increased pod production. • Sale of side branches to Transtech	• Plantation stands established at target sites	• Organized pods collection and PVA • Availability of pods to processors • Extra employment 28800 man days.	• Increased shelf life of threshed fractions of pods • Ensured availability of pods during lean period	• Milk yield of cattle increased to the tune of 15-20% without any negative effect on health • The feed has positive effect on health of goats	• Instant Juli coffe is ready for commercialization •Mineral rich Juli syrup production in pilot scale
Interventions	•Managed the thickets. •Trained the farmers in silvicultural techniques. •Linkage with Transtech Green Power Ltd.	•Identified sweet pod bearing plant types of *Prosopis* •Raised seedlings in farmers nurseries •Trained the farmers for promoting plantation	• Farmers groups are formed. • Established a pod collection , grading and PVA centre in a village •Capacity building of stakeholder	• For storage used the appropriate bags in wooden cabinets •Modified plot thresher to separate different fractions of *P. juliflora* pods	• Long term experiment conducted at CAZRI experimental unit on cattle and goat. • For horizontal expansion of technologies experimentations on farm level	• Acute and chronic food safety analysis conducted. • Technology for processing Instant Juli coffee and Juli syrup has been perfected
Reasons	• Forest department never gave a thought to manage it. • Farmers had no skill to manage it.	• When P. juliflora introduced 144 years ago, the seed lots used were highly mixed •Difficulty in identifying the plant types.	• Complete lack of awareness about importance of the pods.	Infected and rotten pods can not be used to process products for livestock and human consumption	•No such products available in the market. • Huge quantum of pods were going waste.	• *P. juliflora* pod based products for human are being commercialized in USA, Mexico and Latin American countries. • No such product available in the country
Issues	•Complete ignorance regarding management of *P. juliflora*	Non availability of sweet pod bearing plant types of *Prosopis*	•Massive availability of Pods of *P. juliflora* which goes waste.	• Problems of pods storage. • No machinery for pod thrashing and separating it in different fractions.	• *P. juliflora* pod based livestock products processing, technology validation and commercialization	*P. Juliflora* pod based product for human consumption - technology standardization, protocol on human food safety standard

Annex 5

राष्ट्रीय कृषि नवोन्मेषी परियोजना
भारतीय कृषि अनुसन्धान परिषद्
कृषि अनुसन्धान भवन-२, पूसा
नई दिल्ली – ११००१२.

National Agricultural Innovation Project
Indian Council of Agricultural Research
Krishi Anusandhan Bhawan-II, Pusa
New Delhi – 110 012

CERTIFICATE OF APPRECIATION

Awarded for outstanding contribution in development of *Prosopis juliflora* based value added products under the NAIP sub-project 'A value chain on value added products derived from *Prosopis juliflora*' to research team comprising ***Dr. J.C. Tewari,*** CPI (CAZRI, Jodhpur) and CCPIs ***Shri Prem Raj Parakh*** (Food Products of India, Jodhpur) and ***Shri Shyam Lal*** (DECO, Jodhpur).

Dated: November 16, 2012

(S. AYYAPPAN)
SECRETARY (DARE) &
DIRECTOR GENERAL (ICAR)

(BANGALI BABOO)
NATIONAL DIRECTOR (NAIP)