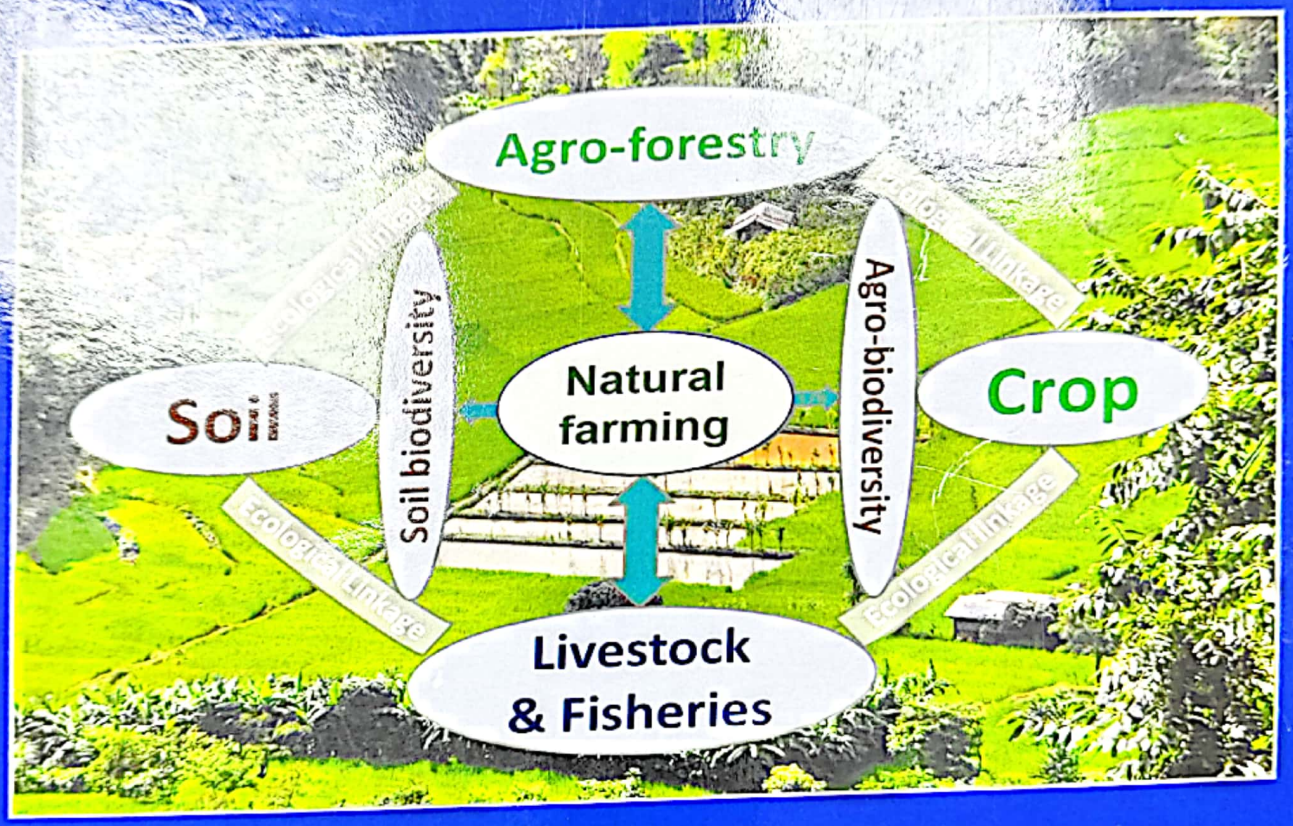
Handbook on Natural Farming

Principles and Practices

Volume-I



Central Agricultural University
Imphal, Manipur

Handbook on Natural Farming

Principles and Practices
(Volume-I)

Coordinating Editor
Dr. Anupam Mishra

Editor-in-Chief
Dr. Puranjan Das

Consulting Editor
Prof. Indira Sarangthem

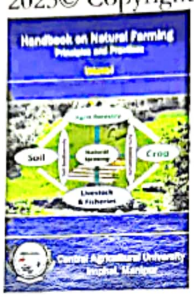
Editors
Prof. Dwipendra Thakuria
Dr. Shravan Manbhar Haldhar
Dr. Lokesh Kumar Mishra
Dr. S. K. Roy
Dr. Jayanta Layek

Central Agricultural University
Lamphelpat, Imphal-795004, Manipur (India)

Citation : Mishra A., Das P., Sarangthem I., Thakuria D., Haldhar S.M., Mishra L.K., Roy S.K. and Layek J. (2023). Handbook on Natural Farming: Principles and Practices. Pub: Central Agricultural University, Imphal, pp. 629., ISBN: .....

Publisher : Central Agricultural University, Imphal (Manipur), INDIA

First edition : 2023© Copyright reserved with the editors



Editors :

Coordinating Editor
Dr. Anupam Mishra

Editor-in-Chief
Dr. Puranjan Das

Consulting Editor
Prof. Indira Sarangthem

Editors
Prof. Dwipendra Thakuria
Dr. Shravan Manbhar Haldhar
Dr. Lokesh Kumar Mishra
Dr. S. K. Roy
Dr. Jayanta Layek

नरेन्द्र सिंह तोमर
NARENDRA SINGH TOMAR

सत्यमेव जयते

आजादी का अमृत महोत्सव

कृषि एवं किसान कल्याण मंत्री
भारत सरकार
कृषि भवन, नई दिल्ली
MINISTER OF AGRICULTURE & FARMERS WELFARE
GOVERNMENT OF INDIA
KRISHI BHAWAN, NEW DELHI

FOREWORD

A unique magnificent performance was vividly demonstrated by Indian agriculture, by transforming a high food deficit country to a highly food surplus country, with a mere 50 million tonnes of food grains for a population of 330 million in 1947 to an estimated 330.7 million tonnes for a population of 1425.7 million in 2023; creating an overarching mechanism of food security simultaneously through buffer stock steadily grown over the period with an all-time peak of 64.7 million tonnes.

Similarly, a spectacular performance in the history of mankind was during the major global humanitarian crisis due to COVID-19 when the Global stock-to-use ratios of food grains recorded extraordinarily high, added by trade restrictions and precautionary measures, widespread lockdown, export restrictions, the decline in production in the countries most threatened by the locust infestations, and unprecedented logistic challenges; the country came forward for the world community and opened its granary of staples to supply rice, wheat, sugar, other cereals and meat valued USD 50 billion, the highest ever exports by the country.

Another landmark demonstration of innovativeness by the planners and policymakers is the launching of a giant programme of Natural Farming covering 1.6 million farm families in the background of the increasing concerns for degradation of natural resources and uneven development across the regions, crops, and different sections of farming communities. The programme is one of the finest holistic approaches to meet the emerging four-fold challenges of agriculture: enhance production and productivity, address issues of equality and uneven development, sustainability issues, and enhance profitability in agriculture.

India Shares (2019) 2.44 % of the World Area, 11.28 % of World Arable Land, 17.73 % of World Population, 4.00 % of Water, 12.70 % of Cattle, 56.70 % of Buffaloes, and14.50 % of Goats. The national policy on agriculture, formulated recently, seeks to actualize the vast untapped growth potential of the country's natural resources of land, water and genetic endowment to promote sustainable development of agriculture. India has committed to addressing land degradation and restoring the ecosystem. The country is dedicated to achieving land degradation neutrality by 2030. It has identified achieving land degradation neutrality as a means to recover biodiversity. In the process of institutionalization, the Indian Council of Agricultural Research promptly decided to open undergraduate, postgraduate and Doctor degree programmes in Natural Farming at Central Agricultural University, Imphal right in the ensuing academic session.

The decision of Central Agricultural University, Imphal to bring out the "**Handbook on Natural Farming: Principles and Practices**" is a timely action in a spirit of resilience in providing the primary source of learning for students, young scientists, researchers, practitioners, planners and policymakers and farmers. I congratulate the experts and the members of the Editorial Boards for developing this valuable compilation covering specific topics relevant to Natural Farming as a science in totality under the able leadership of Dr. Anupam Mishra, Vice Chancellor, Central Agricultural University, Imphal, Manipur and the Way Forward for actualization and practicalization of the principles and practices of Natural farming.

I congratulate the Members of the Editorial Board for making painstaking efforts to bring out this wonderful publication.

(Narendra Singh Tomar)

Office : Room No. 120, Krishi Bhawan, New Delhi-110 001 Tel.: 23383370, 23782691 Fax : 23384129
Resi. : 3, Krishna Menon Marg, New Delhi-110001, Ph. : 011-23794697 / 98, Fax : 011-23794696

सत्यमेव जयते

डॉ. हिमांशु पाठक
DR. HIMANSHU PATHAK
सचिव (डेयर) एवं महानिदेशक (आईसीएआर)
Secretary (DARE) &
Director General (ICAR)

भारत सरकार
कृषि अनुसंधान और शिक्षा विभाग एवं
भारतीय कृषि अनुसंधान परिषद
कृषि एवं किसान कल्याण मंत्रालय, कृषि भवन, नई दिल्ली–110 001

GOVERNMENT OF INDIA
DEPARTMENT OF AGRICULTURAL RESEARCH AND EDUCATION (DARE)
AND
INDIAN COUNCIL OF AGRICULTURAL RESEARCH (ICAR)
MINISTRY OF AGRICULTURE AND FARMERS WELFARE
Krishi Bhavan, New Delhi 110 001
Tel: 23382629 / 23386711 Fax: 91-11-23384773
E-mail: dg.icar@nic.in

Azadi ka Amrut Mahotsav

G20

FOREWORD

India, a "ship-to-mouth" food economy, has undergone a complete transformation to become one of the Top Agricultural Producing Countries in the World and a Harbinger of Knowledge through a network of innovative institutional arrangements in agricultural research, education and application of technology. India proved wrong the prediction of a team of experts visiting India in 1964 that an "intractable agricultural problem that would lead to the death of millions in the 1970s".

India is the world's second-largest producer of wheat, rice, groundnuts, fruits, vegetables, potatoes, tea, and sugarcane. It is also the largest producer of milk, pulses, and jute. More than half of the population still relies mainly on agriculture for their income. From 17.8% in 2019–20, agriculture's contribution to India's GDP climbed to 19.9% in 2020–21. Despite its prediction of a "sharp, long-lasting slowdown" and a reduction in global growth to 1.7%, the World Bank maintained India's economic growth at 6.9% for the fiscal year 2022–23 due to the substantial expansion of agriculture.

The National Policy 2007 for Farmers recognised the need to concentrate more on farmers' financial health than only on productivity. To gain a better knowledge of the benefits of agroecology and natural farming systems, the National Dialogue on Enhancing Farmers' Income, Nutritional Security, and Sustainable Food Systems (19-22 January 2021) discussed "Natural Farming, Agro-ecological, and Biodiverse Futures." Despite being one of the subsets of practices used in the contemporary agricultural landscape, natural farming techniques have a considerable positive impact on preserving and enhancing agrobiodiversity and soil biodiversity. The potential of such systems to address the issues of food and nutritional security, achieve maximum efficiency in the use of natural resources, integrate technology and innovation, increase climate resilience, and ensure economic viability were well discussed across various chapters.

The Government of India has launched a giant programme of Natural Farming covering 1.6 million farmers over 1.0 million hectares. In the process of institutionalisation and bringing resilience to the concept, the Indian Council of Agricultural Research decided to provide strong backup by opening undergraduate, postgraduate, and Doctor Degree programmes in Natural Farming at Central and State Agricultural Universities across the country right in the ensuing academic session.

I am so pleased to see the efforts of the Central Agricultural University, Imphal, in bringing out such an innovative publication, "**Handbook on Natural Farming: Principles and Practices**" vol.1, under the visionary leadership of Dr. Anupam Mishra, Vice Chancellor, CAU Imphal, Manipur. I compliment the authors and the editors for creating a fundamental knowledge base in the form of a Handbook espousing the cause of the farming community, teachers, students, planners and policymakers, and all those engaged in streamlining the process of Natural Farming in the country.

(Himanshu Pathak)

CENTRAL AGRICULTURAL UNIVERSITY
LAMPHELPAT, IMPHAL-795004, MANIPUR (INDIA)

Dr. Anupam Mishra
Vice-Chancellor

Tel: 0385-2415933
Email: vcofficecau@yahoo.in

PREFACE

India is an agrarian country and agriculture provides a living for more than 58% of India's people. Food production expanded significantly to the extent that the country transformed from the position of **"Sacrifice one meal at least once a week"** to a food surplus country with a buffer stock reaching an all-time high level of 77. 23 million tonnes on April 1, 2021.

India is an ancient civilisation with an ocean of knowledge and wisdoms in various domains of human life. In recent years, the focus of policymakers and planners is on "Income-Centric Initiatives" that encourage farmers to adopt economically viable and environmentally sound farming practises such as "Natural Farming" in order to meet the multiple challenges of climate change, issues related to sustainability due to resource degradation, and increased cost of cultivation. Indian Council of Agricultural Research, New Delhi has initiated undergraduate, post graduate and Ph.D. degree programmes in "Natural Farming" beginning with the Academic Session 2023-2024. The syllabus of the course, prepared by a group of distinguished academicians, agricultural researchers, actual farmers, and non-governmental organisations (NGO) across India.

In resilience, the Central Agricultural University, Imphal repared an authentic comprehensive reference book covering the subject areas that is easy for students and teachers to comprehend. The publication is a ***"Student Focussed"*** reference book incorporating a wider base of knowledge by blending the relevant materials generated from the international conference on Natural Farming with the expertise and knowledge of a team of experts and the eminent resource persons leading to creation of this **"Handbook on Natural Farming: Principles and Practises"**. The book was envisioned for use in undergraduate and post graduate degree programmes in natural farming and resource management, as well as a primary source of learning for students, young scientists, researchers, participants, planners and policy makers, and farmers in general.

This publication is prepared after rigorous review of authentic, academically sound and scientifically proven principles that have been compiled in 15 different chapters preceded by an Introduction written by leading experts from ICAR and State/Central Agricultural Universities. Each and every chapter has been meticulously reviewed by luminaries in the field of Agriculture Sciences in India. Being the first effort on such a scale there may be unintentional errors which may have crept in during the publication despite the best efforts of the editorial team. We shall welcome any suggestions with an open mind and assure that these shall be appropriately included in future. In order to facilitate the systematic process of collection and classification of all related knowledge, it has been planned to bring two volumes of this handbook.

I sincerely hope, this book will encourage interaction and discussion among all stakeholders besides the academicians and students. It will stimulate discussion and deliberations that will intensify, divert, and revive the focus towards development of Natural Farming and Agriculture Sector in India.

(Anupam Mishra)

Content

3.	Balancing Ecological Footprint and Biocapacity through Natural Farming-based Food Systems in South Asia	Dr. P. Das, Former Deputy Director General (Agricultural Extension), ICAR, New Delhi, INDIA Corresponding author e-mail: pdasicar@gmail.com	Dr. P. Das, Former Deputy Director General (Agricultural Extension), ICAR Dr. Shravan M Haldhar, Associate Professor, Central Agricultural University, Imphal, Manipur, INDIA
4.	Indigenous Technical Knowledge and its Validation for Natural Farming	Dr. P. Das, Former Deputy Director General (Agricultural Extension), ICAR, New Delhi, INDIA Dr. A. Mishra, Vice Chancellor, Central Agricultural University, Imphal, Manipur, INDIA Dr. S. K. Roy, Director, ICAR-Agricultural Technology Application Research Institute, Pune, Maharastra, INDIA Corresponding author e-mail: pdasicar@gmail.com	Dr. P. Das, Former Deputy Director General (Agricultural Extension), ICAR, New Delhi, INDIA
5.	System Diversification in Natural Farming	Dr. Subhash Babu, Division of Agronomy, ICAR-Indian Agricultural Research Institute, New Delhi-110012, INDIA Dr. Shravan M Haldhar, Associate Professor, Department of Entomology, College of Agriculture, Iroisemba, Central Agricultural University, Imphal, Manipur, INDIA Dr. Jeetendra Kumar Soni, ICAR-RC NEH Region, Mizoram Centre, Kolasib –796081, Mizoram, INDIA and ICAR-Indian Grassland & Fodder Research Institute, Jhansi- 284003, Uttar Pradesh, INDIA Dr. KI Singh, Professor and Head, Department of Entomology, College of Agriculture, Iroisemba, Central Agricultural University, Imphal, Manipur, INDIA Dr. M. K. Jat, Department of Entomology, CCSHAU, Hisar, Haryana, INDIA CN Nidhi, Department of Entomology, College of Agriculture,	Dr. Shravan M Haldhar, Associate Professor, Department of Entomology, College of Agriculture, Iroisemba, Central Agricultural University, Imphal, Manipur, INDIA Dr. Subhash Babu, Division of Agronomy, ICAR-Indian Agricultural Research Institute, New Delhi-110012, INDIA

Wackernagel, M., Galli, A., Hanscom, L., Lin, D., Mailhes, L. & Drummond, T. (2018). Ecological Footprint Accounts: Criticisms and Applications. In Handbook of Sustainability Indictors; Bell, S., Morse, S., Eds.; Routledge International Handbooks; Routledge: Abingdon, UK, 2018; pp. 521–539. Routledge
Wackernagel, M. & Kitzes, J. (2008). Encyclopedia of Ecology, 2008
Wikipedia, the free encyclopaedia. Natural farming, https://en.wikipedia.org/wiki/Natural_farming, accessed 02.01.2023

Chapter: 4

Indigenous Technical Knowledge and its Validation for Natural Farming

Introduction

The spectacular performance of Indian agriculture, witnessed during the past forty years against the rising demographic pressure is a vivid demonstration of the effectiveness of our agricultural research and development system with committed researchers, extension personnel and hard-working farming community. However, there are concerns for uneven development and degradation of natural resources across the regions, crops, and also different sections of farming communities. The agricultural challenges are four-fold: enhance production and productivity, address issues of equality and uneven development, sustainability issues, and enhance agriculture profitability (Das *et al.*, 2002).

Sustainability Science (SS) is considered an emerging discipline, applicative and solution-oriented whose aim is to handle environmental, social and economic issues in the light of cultural, historical and institutional perspectives. The challenges of the discipline are not only related to better identifying the problems affecting sustainability but to the actual transition towards solutions by adopting an integrated, comprehensive and participatory approach. The following main features characterize the emerging SS:

- Focus on dynamic interactions between nature and society: understanding dynamic interactions, vulnerability and resilience of complex social–ecological systems at a systemic level requires a holistic approach and perception of reality.
- Transdisciplinary approach: in order to assess, understand and find solutions to complex phenomena there is a need to bring together the different levels of knowledge of reality, under a reductionist or holistic view; and
- Transformational function (functional to the development of joint and coordinated strategies to solve sustainability problems (Sala *et al.*, 2012)

The world's population is predicted to expand to approximately 10 billion by 2050. It is expected that in a situation of modest economic growth, this will boost agricultural demand up to 50% compared to 2013 (FAO, 2017). Expanding food production and economic growth have often come at a heavy cost to the natural environment. Over the years, there has been a significant decrease in forest cover and biodiversity. Groundwater sources are also getting depleted rapidly. High-input, resource-intensive farming systems

have caused massive deforestation, water scarcity, soil depletion and high levels of greenhouse gas emissions.

A transformational process towards 'holistic' approaches such as agro-ecology, agro-forestry, climate-smart agriculture, and conservation agriculture is a necessity. Practices such as agro-ecology, including Natural Farming, result in better yields without compromising the needs of the future generations. They are advocated by FAO and other international organizations (NITI Aayog, 2021).

Natural Farming (NF) or Zero Budget Natural Farming (ZBNF), as commonly known, is purported to be a disruptive farm practice addressing farmers' significant concerns about the rising production cost. It envisages ecological or regenerative agriculture approaches under which applying chemicals to soil biosystems is prohibited. It relies more on soil biology than soil chemistry by encouraging multi-cropping, round-the-year soil cover, the addition of formulation made up of cow dung and urine to trigger the microorganisms in the soil system' (Kumar *et al.,* 2020)[5].

Natural farming is also referred to as "the Fukuoka Method", "the natural way of farming" or "do-nothing farming", is an ecological farming approach established by Masanobu Fukuoka (1913–2008), and introduced the term in his 1975 book The One-Straw Revolution (Fukuoka, 1975 (in Japanese) and (in English) 1978). The title refers to the avoidance of manufactured inputs and equipment. Natural farming is related to fertility farming, organic farming, sustainable agriculture, agroecology, agroforestry, eco-agriculture and permaculture, but should be distinguished from biodynamic agriculture (Wikipedia, the free encyclopedia).

It is a diversified farming system that integrates crops, trees and livestock, allowing the optimum use of functional biodiversity. Natural Farming if done effectively enhances farmers' income while delivering many other benefits, such as restoration of soil fertility and environmental health, and mitigating and/or reducing greenhouse gas emissions. Natural Farming builds on natural or ecological processes that exist in or around farms (NCONF).

Indigenous Technical Knowledge (ITK) in agriculture, animal husbandry, fisheries and other allied activities has been used for ages by farmers, animal owners and other practitioners. Advancement in scientific knowledge in agriculture has questioned the rationality of ITKs and replaced these ITK-based practices. The sustainability problems of modern scientific technologies and their impact on the ecosystem and environment have evoked interest in ITKs recently.

The Indian Council of Agricultural Research (ICAR) took up a Mission Mode Project on 'Collection, Documentation, and Validation of Indigenous Technical Knowledge' under National Agricultural Technology Project (NATP) from 2000 to 2004. The project was launched with the following objectives (Das *et al.*, 2002):

- Identify, collect, classify and document ITK and its variants in different agro-climatic regions in respect of production systems, farming systems and situations;
- Catalogue and characterize the information for developing a database;
- Ascertain the propensity of the extent and level of use of various ITK by the fanners in the management of various farming systems;
- Validation of ITK through a quick screening method and through formal experiment ation,
  wherever needed; and
- Evolve a mechanism to protect property rights and facilitate the process of sharing t he benefit by the farming community.

Information on ITKs were initially collected from secondary sources like journals, reports, thesis, etc. and documented in 2002 in the Inventory of Indigenous Technical Knowledge in Agriculture publication. Document 1', which includes 1657 ITKs. Subsequently, information on indigenous knowledge-based practices was collected from primary sources through voluntary disclosures. These were documented in three publications entitled 'Inventory of Indigenous Technical Knowledge in Agriculture. Document 2' (1998 ITKs) (Das *et al.*, 2003a) and its supplements 1 and 2 (562 and 846 ITKs respectively) (Das *et al.*, 2003b' and Das *et al.*, 2004a). Thus, a database of 5063 ITKs was created. The field survey method, using various tools of Participatory Rural Appraisal (PRA), was conducted at the sites where these ITKs were used to ascertain the extent of use of the ITKs and opinions of the users regarding its efficiency on the concerned problem.

Validation of ITKs is an important aspect, which has remained almost untouched from research agenda. In this direction 111 ITKs were taken up for experimental validation which include 14 thematic areas, viz., rain water management, soil and water conservation, tillage practices, crops and cropping systems, pest and disease management, farm implements, seed storage, horticulture, veterinary science and animal husbandry, fisheries, food product development, natural yarns and dyes, ethnic food and thermal efficiency and case studies in two thematic areas, viz., methods of weather forecasting and low-cost housing materials. The results have been very interesting and extremely important for finding the scientific rationale of traditional wisdom and knowledge (Das *et al.*, 2004b). The scientists of the ICAR Institutes and State Agricultural/Animal Science Universities all over the country carried out the experimental validation.

The initial results of 111 selected ITKs were published in 2003 in the fourth volume entitled, 'Validation of Indigenous Technical Knowledge in Agriculture - Document 3'. Some of the promising ITKs were subjected to cross-sectoral validation studies at additional research centres, while some of them required further studies as well as in-depth analysis, including identifying active ingredients contained in it.

Out of 111 ITKs, 37 such ITKs were taken up for such analysis, of which, 13 were single-centre experiments, and the remaining 24 were validated cross-sectoral, *i.e.*, at more than one location in different zones (Das *et al.*, 2004b) (Table 4.1).

Table 4.1. Details of ITKs for experimental verification

S. No.	Thematic Areas	Single Center	Cross-Sectoral	Total
1.	Rainwater Management	2	1	3
2.	Soil and Water Management	1	-	1
3.	Pest and Disease Management	2	4	6
4.	Horticultural Crops	4	5	9
5.	Farm Implements	2	-	2
6.	Fishery	1	-	1
7.	Veterinary Science and Animal Husbandry	1	14	15
	Total	13	24	37

A. Single centre experimentation in 7 thematic areas (13 ITKs):

1. Rainwater Management
2. Soil and Water Management
3. Pest and Disease Management
4. Horticultural Crops
5. Farm Implements

6. Fishery
7. Veterinary Science and Animal Husbandry

1.Thematic area: rainwater management

There were two ITKs collected on Rainwater Management on which Single Centre Experimentations were conducted for its validation, the details of which are given in Table 4.2.

Table 4.2. Details of ITKs on Rainwater Management for Single Centre Experimentations

S. No.	Title of ITK	Experimenting Organization
1.	Rainwater measurement using *rolu* (indigenous rain gauge	Central Research Institute for Dryland Agriculture, Hyderabad
2.	Method of rainwater management in mountainous landscape under apple orchard	Ch. Sarwan Kumar Krishi Vishwa Vidyalaya, Palampur

1. 1. ITK: Rainwater measurement using *rolu* (indigenous rain gauge)

Description of the ITK: *Rolu* (7.4" depth, 9" diameter hole on a 3'x3'xl.5' granite stone block) is useful in knowing the quantity of rainfall for sowing. Seeds in the field are sown when the *rolu* is filled with rainwater. This technique helps the farmers in estimating the rainfall that is sufficient to go for seeding. This method is adopted for sowing dryland crops like sorghum, castor etc. in Alfisols.

Location of use of the ITK: Nallavelli village, Yacharam mandal, Ranga Reddy dist, Andhra Pradesh

Experimenter: Central Research Institute for Dryland Agriculture, Hyderabad, Andhra Pradesh

Methodology: Discussion with the discloser and other farmers of the area: Interacted with the discloser (farmer) to consider the finer details of using the indigenous rain-gauge for validation. The other farmers in the surrounding villages further confirmed this practice.

Fabrication of indigenous rain-gauges: Rain gauges were fabricated with the help of a local mason with the specifications recorded as claimed by the discloser

Validation: Experimental validation was done under both on-station (CRIDA Research Farms at Gunegal and Hayathnagar) and on-farm situations in the villages of Nallavelli, Nasdik Singaram of Ranga Reddy district and Gollapalli village of Nalgonda district during rainy (kharif) season from 2002 to 2004. Indigenous rain gauges were installed nearby standard rain-gauge, at all the study sites to compare their efficiency in terms of validation, refinement and correlation of the various agricultural operations with rainfall in commonly cultivated rainfed crops such as sorghum + pigeon pea, castor etc.

At each site, a circumference area of ½ km was taken as a unit for the study. The study area under each site was marked in four directions of North, East, South, and West. The fields covering the study area were given the code numbers in the form of F1 ... series and mentioned the crops. The monitoring on various agricultural operations for each crop was monitored, and the field area belonging to different farmers in the study area was documented. Areas falling under different farmers in the study area were documented. The operations performed by different farmers in the study area under different crops were documented in relation to the rainfall received in the standard and indigenous rain-gauges mounted side by side. Further, the quantity of rainfall received in both indigenous and standard rain gauges on different dates from June to September was correlated by taking

the parameters of the volume of water stored in both types of rain-gauges, considering the surface area collecting rainfall in each rain gauge.

Based on these parameters, a correction factor was determined to correlate the quantity of rainfall received in indigenous rain-gauge with the rainfall of standard rain-gauge. Operations performed for raising the crops in relation to rainwater received in the rain-gauges were recorded. The loss of rainwater in the form of overflow, splash and human interference was recorded for refinement of the indigenous rain gauge.

Results and Discussion: A correlation was developed between the rainfall received through indigenous and standard rain-gauges for all the years. During the process, a correction factor was developed to quantify the rainfall of indigenous rain-gauge (IR) to test the validity of rainfall with standard rain-gauge (SR). The parameters included to derive the correction factor are surface area and volume.

Correlation: To correlate the rainfall of the indigenous rain gauge with the standard rain-gauge, derivation of Surface area ratio is required. It was arrived at by:

Surface area ratio = Area of standard rain gauge/area of indigenous rain-gauge

= 200 cm 2 /398 cm 2 = 0.50

The results were validated over the study area by developing a correction factor for its wider applicability with the similar specifications of the rain-gauges used in the present study. To develop a correction factor, the rainfall data obtained from both the rain-gauges were fitted with the linear relationships, as:

$R_s = C_f X R_i$

Where

R_s = Rainfall measured by standard rain-gauge (mm)

C_f = Correction factor

R_i = Rainfall measured by indigenous rain-gauge (mm)

In the first year of experimentation, the pooled correction factor observed was 0.32. The model was further validated with the rainfall data measured from the experimental sites, which is very nearer to the theoretical correction factor. A positive correlation was observed with the rainfall measured by both indigenous and standard rain gauges, with high coefficient of determination, R2 = 0.92. The quantity of rainfall received from the indigenous rain-gauge and the operations carried out by the farmers of the surrounding fields were recorded.

Operations were performed in relation to the depth of rainwater received in indigenous rain-gauge on-station trials and on-farm trials on Sorghum+ pigeon pea for three years.

Conclusion: When the indigenous rain-gauge was full, sorghum + pigeon pea was sown by all the framers within 3 days, which technically amounts to 50 mm in the standard rain-gauge. Sowing can be continued for 2 more days. With this, it fulfils the claim made by the discloser. But the claim gets vitiated under delayed monsoon conditions because the season to sow sorghum + pigeon pea would be lost for fear of sorghum shoot fly attack, and the farmer will prefer to sow castor instead of sorghum + pigeon pea. The low price of the indigenous rain-gauge made of granite ranges from Rs 250 to 300, which the local mason can make, and its less proneness to theft over the standard rain-gauge are the significant advantages.

1.2. ITK: Method of rainwater management in the mountainous landscape under apple orchard

Description of the ITK: Villages are located at the foothills or valleys in several parts of the Himalayas. Villagers often harvest rainwater by building small water-storage "ponds" (locally called *chaal*). The size of the pond is 9 m long, 9 m wide and 0.9 m deep, and the number of such ponds varies from 30 to 40 depending upon the valleys and villages. During

the rainy season, water gets stored in these ponds, which act as a water reservoir for the villagers and control the floods in the low hill areas during the rainy season. The water collected in the ponds is not used for drinking purposes but used for cattle and irrigation purposes.

Location of use of the ITK: The experimental site was an apple orchard, located at village Gawahi, which is 45 km from Shimla city on national highway 22 (commonly called Hindustan-Tibet Road) and 8 km from Theog town, which is a gateway to apple belt of Shimla district. The orchard was about 3 ha in area, at 2,400 m above MSL, established 10 years ago.

Experimenters: Department of Soil Science, Ch. Sarwan Kumar Krishi Viswa Vidyalaya, Palampur (Himachal Pradesh).

Methodology: The landscape is very steep, with a slope of 70- 75% (Fig. 1). About 500 apple trees were planted along the visually observed contours at 3-6 m spacing. The trees are being fertilized regularly with chemical fertilizers and farmyard manure. The orchard is entirely rainfed. There is no source of water for irrigation. The rainfall needs to be more adequate and highly variable in distribution. The apple trees therefore often experience moisture stress. Consequently, these are weak and need to show full vigour. This experiment was conducted during 2002- 2004. Two sets of treatments were imposed in this study.

1. For *in-situ* rainwater harvesting and profile moisture conservation, the following three sets of treatments, in addition to control, were tested: mulching, terracing + mulching, and terracing + trenching + mulching.
2. For testing *chaal*, five types of dug-out tanks were constructed at appropriate locations in the experimental area, viz. (i) polyethylene-lined tank, (ii) bitumen (tarcoal)-lined tank, (iii) cement+ concrete lined tank (RCC), (iv) mud-plastered tank, and (v) unlined tank (control).

The whole experimental site was divided into three blocks for imposing the following treatments: i) Terracing: Land shaping between two apple trees along the contours in such a way that rainwater flows towards the tree basins, ii) Trenching: Small trenches of appropriate sizes were dug above the tree basins to harvest rainwater in situ. iii) Mulching: The tree basins were mulched with FYM, pine needles, pebbles, and coco pit, in addition to unmatched control.

Terracing was done in two blocks of the. Terraced block experimental area, covering 20 plant rows, with a total length of 2,040 m. The average width of these terraces was 1.5 m. It involved an earthwork of about 1,530 m3. A gentle side-wise slope was given on each terrace to direct the runoff during rainstorms, if any, towards the tree basins. Trenching Trenches (0.3-0.4 m deep and 0.3-0.4 m wide) were made along the hillside wall, above the apple tree basins. The total length of trenching, covering 11 plant rows, was 1,122 m. The average breadth and depth of these trenches was 0.304 m each. Trenching involved an earthwork of 103.6 m3.

Mulching The tree basins were mulched with farmyard manure (10-15 cm thick layer), pine needles, coco pit (prepared from coconut fiber) and pebbles (single layer) (Figs 4-7). The coco pit was either mixed with soil or spread over the soil surface of the tree basin. Five trees with each type of mulch, including the control without mulch were tagged for taking observations on the effect of water harvesting or conservation on the growth and vigor of apple trees. Before spreading the polyethylene sheet in the dug-out tank, the tank's walls were smoothened to avoid puncturing of sheet. Molten bitumen was sprayed on the tank's walls with the help of a metal container with numerous small holes in the side wall. For mud plastering, dry, chopped grass was mixed with dry soil in the ratio of 1:10. The

mixture was saturated with water, and kneaded thoroughly to convert it into a soft plastic mud.

Observations were recorded on general features of the area, initial characterization of the soil for texture, water retention, particle density, bulk density, infiltration rate, pH, organic C and available NPK, soil moisture (0-60 cm depth) in tree basins under different mulch treatments, water storage and seepage losses in different dugout tanks, rainfall, and potential evaporation of the area. The soil moisture was determined gravimetrically at periodic intervals under different treatments. Growth parameters like plant height, canopy circumference, apple tree stem girth, and relative leaf-water content were monitored for 2004. Soil samples were collected at six locations in the orchard up to a depth of 60 cm at 15 cm depth increment.

Six soil samples for each depth were thoroughly mixed, and a composite sample was prepared. The composite soil samples were analyzed in duplicate for texture (International Pipette method), organic carbon (Dichromate oxidation method of Walkley and Black), available N (Alkaline permanganate method), Olsen's P, exchangeable K (Ammonium acetate method), pH (1:2.5 soil. Water suspension) and particle density (Pycnometer method). Soil moisture retention of disturbed soil samples (soil passed through 2 mm sieve) was determined at saturation, -30 and -1500 kPa water potential, using Pressure plate apparatus. Bulk density was determined using 3 cm long and 5.6 cm diameter metal cores, by taking soil core from the middle portion of each soil layer. Results were analyzed in terms of the instability of terraces and trenches, Soil-moisture conservation, effect of mulching on soil-moisture conservation and water status of apple trees, and the effectiveness of different types of dig-out-tanks.

Conclusion: These studies have shown that *chaal* is an effective structure for harvesting water from lining material. Bitumen, being hydrophobic in nature, is also effective in reducing seepage losses from farm ponds, but its mode of application needs to be standardized in loose and gravelly soils.

Land shaping (terracing and trenching) was very effective in conserving soil moisture in tree basins by directing the run-off water towards tree basins and harvesting the rainwater. The moisture conservation effect was further enhanced when land shaping was coupled with mulching. Pine needle mulch was comparatively more effective in moisture conservation. The pebble mulch was also effective and may be easy to apply at on farm level because of its easy availability locally. However, due to the fragile nature of the landscape, the terracing and trenches were damaged due to snowfall and rain and had to be repaired even after 1 year of construction. The effect of soil moisture conservation through land shaping and mulching was significantly observed on the growth of apple trees.

2. Thematic areas: soil and water conservation using salt technology

Table 4.3. Details of ITKs on Soil and Water Conservation for Single Centre Experimentations

S. No.	Title of ITK	Experimenting Organization
1.	Cultivation of apple in Himalayan region	Ch. Sarwan Kumar Krishi Vishwavidyalaya, Palampur

2.1. ITK: Cultivation of apple in the Himalayan region using SALT Technology

Description of the ITK: Traditional apple-orchard farming involves using contour ditches, water-control canals, soil traps, bench terraces and hedge rows of fast-growing leguminous plants, which have been adopted by the farmers of Himalayan region. Soil and water erosion is a severe problem in hilly regions. Since earlier times farmers used to

practice this technology in an integrated way to improve soil and water conservation and manage nutrients in apple orchard. This technology helps in stabilizing the fragile eco-system dominated by the apple-farming system. Use of such technologies lays focus on soil and water conservation as well as fertility management, resulting in a paradigm shift towards maximization of productivity, profitability, and sustainability of hill eco-system. This has been in practice for several years.

Location of use of the ITK: Farmers in Himalayan region

Experimenter: CSKHPKV, Palampur, Himachal Pradesh.

Methodology: The ITK-based technology has variously been termed Sloping Agriculture Land Technology (SALT). SALT is a package technology on soil conservation and food production, integrating different soil-conservation measures in just one setting. Basically, SALT is a method of growing field and permanent crops in 3-5 m wide bands between contoured rows of nitrogen-fixing trees. The nitrogen-fixing trees are thickly planted in double rows to make hedgerows. When a hedge is 1.5 to 2 m tall, it is cut down to 75 cm and the cuttings (tops) are placed in alleyways to serve as organic manures.

Experiment: Experiments were conducted for characterization of the site and evaluation of experimental soil, evaluation of the prevalent practice of the hedge-row cultivation of the apple plants and others on the sloping lands, field mapping of the discloser's area, preparation of the stratified diagrams of the plantation, contour testing, important value index (IVI) exercise of the area to know the present ecological status of the land, productivity estimation of the area, secondary data collection of the biomass and the economic yield of the SALT practiced area of the discloser, terracing and plantation of grass on terraced land. The experimental site was an apple orchard in village Gawahi, located at 45 km from Shimla city on National Highway 22 (commonly called Hindustan-Tibet Road) and 8 km from Theog town, which is a gateway to apple belt of Shimla district. The orchard was of about 3 ha area, at 2,400 m above msl, which was established 10 years ago. The landscape is very steep, with a slope of 70- 75%. About 500 apple trees were planted along the visually observed contours at a spacing of 3- 6 m. The trees are being fertilized regularly with chemical fertilizers and FYM. The orchard is completely rainfed.

The important activities were Soil characterization, Field mapping, Contour testing, Important Value Index exercise, Performance and productivity estimation of the area, and Comparison of grasses on terraced SALT and non-SALT areas.

Conclusion: Contour orchard farming and terracing are the pre-requisites of the steep-slope orchard raising, as has been tried in the ITK. Sl slopes were managed through vegetative structures to mitigate the water stress and soil-erosion condition due to steep slopes. This intervention helped in developing the ecological and economically sustainable land-management system.

3. Thematic areas: pest and disease management

Table 4.4. Details of ITKs on Pest and Disease Management for Single Centre Experimentations

S. No.	Title of ITK	Experimenting Organization
1.	Control of insect-pest in lowland rice using *parasi* (*Cleistanthus collinus*)	Central Rice Research Institute, Cuttack
2.	Planting of wild *Saccharum spontaneum* in paddy field for controlling Rice case worm	Central Rice Research Institute, Cuttack

3.1. ITK: Control of insect-pest in lowland rice using *parasi* (*Cleistanthus collinus*)

Description of the ITK: Approximately 0.4 to 0.5 kg fresh, tender branches of *Cleistanthus collinus* are planted erect or spread in the standing water after establishment of summer rice with the anticipation of pest outbreak. This practice is being followed by a good number of farmers belonging to Kapgari village under Jhargram subdivision in Midnapur district of West Bengal. This practice has been in vogue over generations without any modification and is being followed in patches vulnerable to insect-pest incidence. Rice gundhi bug infests paddy at the milk stage. It sucks the milk, leaving the grain chaffy or partially chaffy, depending upon the extent of infestation. It generally appears in damaging level during rainy (kharif) season in the early maturing varieties that mature during 1st or 2nd week of October.

Location of the ITK use: Kapgari village under Jhargram subdivision in Midnapur district of West Bengal.

Experimenter: Central Rice Research Institute, Cuttack (Orissa)

Methodology: Experiments were conducted during the rainy (kharif) seasons 2002, 2003 and 2004 at Central Rice Research Institute (CRRI), Cuttack and during kharif 2002 and 2003 in farmers' fields of Ajodhya village, Balasore (Orissa). At the research station, 30-day-old seedlings were transplanted in randomized block design for 6 treatments each with 4 replications. Fertilizer was applied @ 60:30:30 kg NPK/ha. Twigs of *parasi* were implanted @ 5/plot (25 m2) and leaves were applied @ 100 kg/ha. Malathion dust was applied @ 25kg/ ha.

Observations were taken on population of *gundhi bug* (after 5 and 10 days of treatment by sweeping net method) and yield of rice. In farmers' fields, only 3 treatments each with 10 replications were taken, i.e., implanting *parasi* twigs, applying insecticides and untreated control. Although a significant increase in yield was not obtained in *parasi* treatment than that of untreated control, insect population was found to decrease in *parasi* treatment in comparison to untreated control.

The experiments conducted at CRRI, Cuttack and in farmers' fields during 2002 revealed that gundhi bug infested the paddy despite *parasi* application, but there was decrease in population for the treatment where it was applied after infestation and applied as fresh.

Conclusion: Gundhi bug population was reduced by both fresh leaves and planting of twigs of *parasi* after infestation.

3.2 ITK: Planting of wild *Saccharum spontaneum* in paddy field for controlling Rice case worm

Description of the ITK: Wild sugarcane (*Saccharum spontaneum*) twigs of height 4 to 5 feet and 4 to 5 cm diameter are planted after 15 days of transplanting in rice field for control of leaf-roller. These erected branches harbor predators at the time of occurrence of leaf-roller, thereby suppressing the incidence of pests. About 90% of farmers in the Benakunda village of Ganjam district in Orissa adopt this practice. Rice case worm, *Nimphula depunctalis Guenee* (Lepidoptera: pyralidae) is an insect pest of rice in low-lying area and waterlogged conditions. Larvae make their cases by cutting the top portion of the leaf and rolling the leaf section around their body with the help of silky threads produced by their saliva. The larvae remain within the case while floating on the water surface. They crawl up rice plants to feed the remaining in their cases. The larvae feed by scrapping patches of green tissue from young tender leaves, leaving only the white epidermis. The damage pattern is not uniform because the larvae floating in their cases are often carried to one side of the paddy field by wind or water currents. Damaged plants become stunted and produce fewer tillers. Wild sugarcane, *Saccharum spontaneum* grows near riverbanks on marshy lands. The plant is used by the farmers of Bhanjanagar area (Ganjam district) to control case worm in rice.

Location of use of the ITK: Village Benakunda, block Bhanjanagar, district Ganjam (Orissa)

Experimenter: Central Rice Research Institute, Cuttack (Orissa)

Methodology: Field experiments were carried out during the rainy (kharif) season of 2002, 2003 and 2004 at two locations, *i.e.*, at (i) CRRI, Cuttack and (ii) farmers' fields in the villages. At CRRI, Cuttack the treatments taken were planting *Saccharum spontaneum* at 7 days after transplanting (DAT), 14 DAT, and after infestation, foliar spray of insecticide (imidacloprid) @ 0.05 kg ai/ha and untreated control. Seeds were sown on 25-28 June. Seedlings were raised in the nursery with all the recommended agronomic practices to obtain healthy seedlings.

Thirty-day old seedlings were transplanted on 25-28 July in randomized block design (RBD), each treatment in 4 replications with 40 m2 area for each microplot (replication). Fertilizer application was made @ 60 N:30 P:30 K kg/ha. Half the dose was applied basal, whereas the rest was applied in two split doses, one at the tillering and the other at panicle-initiation stage. First and second treatments of wild sugarcane were made at the scheduled period. The source of availability of wild sugarcane was found out within 60 km periphery of CRRI. Observations on the percentage of hill infestation and yield of rice were taken. The variety used was Moti. In farmers' fields three treatments were used: planting of *S. spontaneum* at insect infestation, insecticide treatment, and untreated control. Each farmer represented one replication with three plots as three treatments. Each plot size was within the range of 600-800 m2 with 10 replications.

Results and Discussion: Mode of action of *S. spontaneum*: Observations taken on the micro-ecosystem after planting of *Saccharam spontaneum* revealed the following facts:

1) Almost all the leaves of *S. spontaneum* provided habitation for spiders.
2) Spider eggs were available in 65% of *S. spontaneum* implanted on both leaf surfaces and the leaf-sheath portion.
3) The spider population was 2-3/m2 after 5 days of planting of S. *spontaneum*, which gradually increased to 6-8 after 15 days, with small spider nymphs all over the field.
4) Spiders collected from CRRI, Vogra, Bhanjanagar and Kasiadihi belonged to 6 types, which were: *Neoscona sp.*, *Araneus sp.*, *Oxyopes sp.*, *Tetragnatha sp.*, *Clubirna sp.* and *Argeiops sp.*
5) Two types of spiders *Araneus sp.* and *Oxyopes sp.* were observed to kill and devour the larvae of caseworm.
6) Web formation was another mode of action for controlling the caseworm by trapping it at moth stage.
7) High rate of egg laying of some of the spiders was observed on the broad leaf surface of *S. spontaneum*, which perhaps helped in spreading the population less time.
8) The egg masses collected from leaf showed 200-250 spiders hatching from one egg mass. This may be another contribution of *S. spontaneum* to its efficacy against rice caseworm.

Conclusion: Planting of wild sugarcane (*Saccharum spontaneum*) is effective in controlling the infestation of rice caseworm both before and after infestation. It is because wild sugarcane plants help multiply different types of spiders that control the caseworm.

4. Thematic area: horticultural crops

Table 4.5. Details of ITKs Horticultural Crops for Single Centre Experimentations

S. No.	Title of ITK	Experimenting Organization
1.	Control of shoot and fruit borer through use of tobacco (*Nicotiana*	Birsa Agricultural University, Kanke, Ranchi (Jharkhand)

	tobaccum) soaked water in brinjal (*Solanum melongena*)	
2.	Control of rhinocerous beetle in coconut by using cowdung slurry	Tamil Nadu Agricultural University, Coimbatore
3.	Sprouting in yam by cowdung slurry	Regional Centre, Central Tuber Crops Research Institute, Bhubaneswar
4.	Off-season flowering in guava	Bidhan Chandra Krishi Vishwa Vidyalaya, Nadia

4.1. ITK: Control of shoot and fruit borer through use of tobacco (*Nicotiana tobaccum*) soaked water in brinjal (*Solanum melongena*):

Description of the ITK: The shoot and fruit borers are prevalent in Kauwakol, Jorawardih and Mananiyatari villages in Kauwakol block in the Nawada district of Bihar. Tobacco is soaked in water in a ratio of 1: 10 overnight and the extracted liquid is filtered through fine cotton cloth. The filtered material is sprayed either with a spray machine or fine broom. Before spraying, 1-2 teaspoon detergent powder is mixed in the filtered liquid. This is an age-old practice by most of the farmers in these villages.

Location of use of the ITK: village Kauwakol, block Kauwakol, district Nawada, Bihar

Experimenter: Birsa Agricultural University, Kanke, Ranchi (Jharkhand)

Methodology: Participatory Rural Appraisal (PRA) tools were used covering randomly selected 20 respondents in Kauwakol, Sokhodeora and Tikodih villages of Nawada district to elucidate information on the efficacy of the practice focusing the points such as extent of control, effect on quality, effect on human health and environment and on the yield of the brinjal. Qulk matrix scoring method was applied to know the perceptions of the respondents.

Experiments: Field experiments for validation of the ITK were conducted during 2002-2003, 2003-2004 and 2004 in the months of October to April, August to February and April to December, respectively in three different growing seasons.

The experiment was designed in randomized block design (RBD) with 20 replications using three treatments, viz., T1 control, T2, spray of tobacco-soaked water (1: 10) and T3, recommended practice (spray of dimethoate @ 1.0 litre/ha) as chemical insecticide. Each treatment covered an area of 1000 m2. During 2002-2003 and 2003-2004 the brinjal variety—Pusa Purple Long was used whereas during 2004 variety— Mukta Keshi was used for experimentation.

Seedlings of brinjal were raised in nursery bed by sowing seed @ 600 g/ha during all the 3 years of experimentation. The seed bed was prepared 10' long, 4' wide and 6" raised. Between 2 seed beds a two feet wide path was provided for care and management of the nursery plants. About 25 days old seedlings were planted in the 1 st week of November 2002, July 2003 and May 2004 at the spacing of 60 cm row to row and 45 cm plant to plant.

The crop was fertilized with 85: 50: 30 kg NPK/ha. Tobacco stalk @ 60 kg/ha and 40 g/ha detergent powder were used in 600 litre water. Similarly, dimethoate @ 1.0 litre/ha was sprayed at the same intervals. The spraying was started after 5-6 weeks of transplanting at an interval of 15 days. However, during 2004 control measures were applied at intervals of 8-10 days, as insect infestation was observed during the peak of the rainy season. Altogether 5 sprays were done during 2002-03 and 2003-04 whereas 10-12 sprays were done during 2004. Observations recorded were the number of infected shoot/m2, number of infected fruit/m2, yield and economics of cultivation and the data was statistically analyzed.

Results and Discussion: Effect on shoot the lowest insect infestation in shoot (6.2/m2) was recorded when tobacco-soaked water was used to control the shoot borer and it was at par with the number of shoot (6.4/m2) infected when chemical insecticide dimethoate was applied to control the same. These treatments were superior to control.
Effect of fruit: The lowest insect infestation (4.7/m2) in fruit was recorded when the crop was sprayed with dimethoate @ 1.0 litre/ha, and it was at par with the treatment of tobacco-soaked water.
Economic viability: The highest net return (Rs 1,17,112/ha) was recorded when the crop was sprayed with dimethoate and it was at par with the net return (Rs 1,15,335/ha) obtained through use of tobacco-soaked water.
Conclusion: The experiments conducted for 3 years reveal that tobacco-soaked water effectively controls shoot and fruit borers of brinjal, as claimed by the discloser.

4.2. ITK: Control of rhinocerous beetle in coconut by using cow dung slurry
Description of the ITK: Cow dung slurry in wide-mouthed vessel is kept at ground level under coconut plantations to trap the rhinocerous beetle (*Oryctes rhinocerous*). This practice is in use for the last five years by the coconut growers of Thummanayakakanpatty village in Madurai district of Tamil Nadu.
Location of use of the ITK: Thummanayakakanpatty, Peraiyur, Madurai, Tamil Nadu, Pollachi, Coimbatore,
Experimenter: Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu
Methodology: Four trials were conducted at Nangegoundanpur, Thensangam-palayam, Angalakurchi and Thengaiparai villages at Pollachi between January-December 2004. The treatments included in the study are: T1 cow dung slurry @5 kg/2 litre water, T2: cow dung slurry @ 5 kg/4 litre water: T3 cow dung slurry @ 5kg + @ 100g/2 litre water, T4: recommended practice: castor cake @ 2.5 kg/one litre water, T5: untreated check: 5 litre water alone in pot. Wide-mouthed pots (24 cm width x 30 cm height x bottom width 27 cm) were used to trap insects for different treatments. Observations on trapped rhinocerous and scarabeid beetles on fortnightly basis were collected.
Experiments: In all the locations, cow dung slurry and fishmeal powder (T3) attracted more rhinocerous beetles. Castor cake suspension recorded equal performance in controlling insects as that of cow dung slurry and fishmeal powder. Castor cake suspension was found to be superior in mass trapping of scraboid beetles (19 to 74) followed by cow dung slurry and fishmeal that ranged from 15 to 67.
Conclusion: Setting up wide-mouthed pots containing cow dung slurry @ 5 kg + 100 g dried fish meal powder placed at ground level attracted adult rhinocerous beetles up to 29 followed by cow dung slurry @ 5 kg with 2 litre water (18). Castor cake

4.3. ITK: Sprouting in yam by cow dung slurry
Description of the ITK: Tuberous roots of yam are divided into many pieces, weighing 150 to 200 g dipped in freshly prepared cow dung slurry, dried in shade, and kept in sand for sprouting. This results in sprouting within 5-6 days, giving 100% germination. Application of cow dung slurry prevents the entry of micro-organisms, loss of moisture from the cut ends and supply the nitrogen required during initial stages. By this practice the farmers get additional income of Rs 10,000/acre over planting only tops of the tuber. It is being followed by almost all the yam-growing farmers.
Location of use of the ITK: Village Benakunda, Bhanjanagar, Ganjam, (Orissa)
Experimenter: Regional Centre, Central Tuber Crops Research Institute, Bhubaneswar, Orissa

Methodology: To determine efficiency, the details of the methodologies of the experiments conducted at the Regional Centre of Central Tuber Crops Research Institute, Bhubaneshwar, (Orissa) and farmers' fields are presented here.

Experiments: Sprouting and yield of tubers: The experiments were conducted with 3 treatments, viz. (i) ITK method (treatment with fresh cow dung slurry); (ii) recommended practice (treating with 0.05% Bavistin) and (iii) control (no treatment).

Sprouting behavior was studied at the Research Centre and under on-farm conditions (at Bhanjanagar) with 3 replications and 36 tubers in each replication. Sprouting under controlled conditions Experiments with various conditions of organisms isolated from cow dung, unsterilized and sterilized cow dung were conducted to study its effect on sprouting behavior.

The microorganisms were inoculated with the spore concentration of 2x 106 forming units (CFU) per liter. The isolates were identified at the Institute of Microbial Technology, Chandigarh. Biochemical changes occurring during sprouting with relation to phenol, reducing sugar, total sugar and protein were assessed following standard methods. Post-harvest tuber rot *Dioscorea* (yam) tubers were subjected to storage and natural rotting. The rotted tubers were planted in petri plates on potato dextrose agar medium under aseptic conditions. The causal organisms were transplanted to PDA slants. The cultures were again plated and re-isolated. The pathogenicity of rotting organisms was confirmed by inoculation on healthy tubers, for identical symptoms. Soil samples were also subjected to serial dilution agar planting to detect the presence of rotting pathogens. One antagonistic experiment was conducted to study the inhibitory effect of bacteria and actinomycetes, isolated from the cow dung, against rotting pathogens.

Conclusion: The application of fresh cow dung to the cut tubers induced early sprouting. There was little difference in sprouting behaviour beyond 30 days, and hence yam sets can be kept in nursery not more than 30 days before planting in the main fields.

Results of the study also indicate that enhancement of early sprouting is due to nutrients, organic matter content of cow dung, and effect of bacteria and actinomycetes present in the cow dung. The micro flora present in the cow dung and inoculation with three bacteria strains and one actinomycete isolated from cow dung reduced the phenol content in the tuber that is toxic for sprouting and helps in enhancing it. However, sprouting is inversely related to phenol content. Further, in the treated tubers the protein content was high, resulting to increased enzymatic activity in tubers during germination process. One bacterium strain of *Bacillus subtilis* (S104) was found to induce early sprouting 100% sprouting as well as other treatment. The additional nutrient in the cow dung accelerated the sprouting process and the organic matter present in the cow dung absorbed more moisture and prevented water loss. Thus, it helps maintain moisture status in the tuber required for sprouting.

In addition, *Bacillus subtilis* strain and actinomycetes have the property of controlling disease and fungal pathogens. They reduce the disease incidence during sprouting the antagonistic effect of three *Bacillus subtilis* strains, as actinomycetes strain against four fungal diseases, viz., *Sclerotium rolfisii*, *Botryodiplodia theobromae*, *Fusarium sp.* and *Rhizopus sp.* was confirmed by in-vitro study.

4.4. ITK: Off-season flowering in guava

Description of the ITK: The farmers bend down the branches of guava about 45 to 60 days before flowering in 3 to 8 years old plants. The branches are bent towards the outer periphery to open the centre and allow sunlight penetration. After 25 to 30 days, new shoots emerge from the bent portion, which bear profuse flowers. This practice results in a 39%

increase in flowering in early summer and 28% increase in late autumn. Offseason flowering fetches Rs 590 to Rs 600/plant, instead of Rs 150 to Rs 180/plant in the normal season.
Location of ITK use: Twenty-six villages in 4 blocks: block Baripur-I and Baripur II, Joynagar-I and Jaynagar-II, South 24 parganas (West Bengal).
Experimenter: Bidhan Chandra Krishi Vishwavidyalaya (BCKV), Mohanpur, Nadia (West Bengal).
Methodology: Experiments were conducted in seven different guava orchards belonging to farmers of Baruipur. The experimental design was complete randomized design (CRD) and the treatments were: T1, being of branches during summer (April-June) and autumn (October-November), T2, complete removal of leaves from the shoot and decapitation, and T3, control (without any treatment). The ITK technique was also tested at Horticultural Research Station, BCKV during autumn 2003.
Experiments: The number of plants per treatment and per season was three. Uniformly growing 3 years old trees of the varieties Allahabad Safeda and Khaja were selected, and all the trees were given uniform cultural practices. Each plant received 450 g N, 300 g P2O5 and 450 g K2O in two equal split doses, once during 12-15 days before bending operation, and again during marble stage of the fruit growth. The control plants were fertilized during August-September and January. Irrigation was given as and when required. Adequate plant-protection measures were taken. The observations taken were on days required to emerge new shoot, number of new shoot lets/branch, days required to initiate flowering, days required for fruit setting, length of new shoot lets at flowering time (cm), pair of new leaves produced per shoot let at flowering time, number of shoot lets with flower buds/branch, number of fruits/branch at fruit set stage, number of fruits/shoot let at fruits set stage, number of fruits retained up to harvest/branch, number of fruits/plant, average weight of the fruit (g), colour of the fruits, sweetness of the fruits, market price and cost effectiveness.
Result and Conclusion: It was concluded that summer bending of branches produced early emergence of a more significant number of shoot lets/branch, which caused flowering and fruit set in them. But the number of reproductive shoots/branch and fruit set is reduced during summer bending compared with autumn season of bending, which proved superior in respect of production with quality fruits. Bending branches in both seasons produced more fruits during off-season than normal plants.

Bending and pruning treatments induced off-season flowering in guava. The hormonal regulation such as ethylene, IAA and GA3 of new shoot initiation under stress condition had already been established. Definite changes had been observed under the treated shoots regarding total soluble protein, free amino acid, proline, tryptophan, enzyme activity, total carbohydrate, total phenol, chlorophyll and lipid content compared with the control plant. These changes might have influenced profuse shoot initiation from the node of the branches, leading to flowering even in the off-season. Hence, the bending and pruning treatment yield also increased (18.55-48.64 kg/plant) compared with the control plants (15.13 kg/plant).
The nutritive value of the guava fruits had also been influenced by this new practice. In the fruits of treated plants under bending and pruning, total soluble sugar increased (6.66 2-7.69%) but ascorbic acid content decreased (0.212-0.222%) compared with controls.

5. Thematic areas: farm implements

Table 4.6. Details of ITKs on Farm Implements for Single Centre Experimentations

S. No.	Title of ITK	Experimenting Organization
1.	*Pingali dhanti* for intercultural operation in tomato	Central Research Institute for Dryland Agriculture, Hyderabad

2.	*Gnddeli* to uproot ginger	Central Research Institute for Dryland Agriculture, Hyderabad

5.1 ITK: *Pingali dhanti* for intercultural operation in tomato

Description of the ITK: Bullock-drawn *pingali dhanti* can be effectively used for weed control in tomato both during kharif and rabi instead of hand-weeding. It can cover an area of 0.4 ha/day with a cost of operation of Rs 150/ha. By adopting this, clean weeding is achieved. It cost about Rs 100.

Location of use of the ITK: Meerkhanpet village, Kandukur mandal, Ranga Reddy dist. (Andhra Pradesh)

Experimenter: Central Research Institute for Dryland Agriculture, Hyderabad (Andhra Pradesh)

Methodology: The place where the ITK is being practiced was chosen for validation during 2002- 03,2003-04 and 2004. The farmers in that village were stratified as per the size of the holding and were selected representing 5% under each category. Focus group interactions were organized to identify the farmers voluntarily to participate in the validation process.

The implement as per the specifications of *pingali dhanti* was fabricated with the help of local artisans. Five farmers representing different categories were selected and trained to become familiar with the various methodologies to implement the validation programme. Based upon the interaction of selected farmers, an understanding was developed between the farmers and facilitators in selecting the experimental sites, implementing the programme and collecting the pertinent data. The project provided the critical inputs required for the investigation like implements and seeds of improved variety of tomato (cv. Kanchana).

The farmers contributed to the investigation in terms of land preparation, transplanting, imposition of the treatments and harvesting of the experimental produce. The farmers and facilitators jointly collected the pertinent data of the investigation. This process facilitated increase in the participation of the farming community and brought awareness on the utility of indigenous implement and recording the farmers' indicators on the efficiency and effectiveness of the implement under their own situations. Each farmer was treated as a replication, and statistical analysis of data was done for various parameters to find out actual effectiveness of the treatments. The parameters such as field capacity, weeding efficiency and draft of the implements were worked out based upon the following formulae.

Field capacity: It is the actual average rate of field coverage by the implement (ha/day)

Weeding efficiency: It is the ratio of weeds removed by interculture implement or weeding tool to the weeds present in the field. The formula computed weeding efficiency: $Wn = [(Wc-Wt)Wc] \times 100$, where Wn =Weeding efficiency, Wc =Total weed count before weeding/unit area, and Wt =Total weed count after weeding/unit area

Draft of implement: The horizontal component of pull requirement to pull each implement was measured using spring-type dynamometer (kg).

Energy expenditure: To obtain better comparative results, the energy required to carry out interculture and weeding operations under each treatment was converted into energy units using standard conversion factors, and the total energy expenditure per hectare was calculated. The specifications of the implements used to implement the validation of ITK are as follows: *Pingali dhanti*: Frame width: 25 cm; frame length: 30 cm; the height of the frame at the blade point: 60 cm; effective blade length: 30 cm; total weight of the implement: 45 kg; cost Rs. 700.

Traditional blade harrow: Frame length: 53 cm; height of the frame at the blade point: 38 cm; effective blade length: 29 cm; total weight of the implement: 25 kg; cost Rs 700.
The experiment was conducted in Meerkhanpet village with four treatments: T1, interculture with *pingali dhanti;* T2, intercultural with blade harrow; T3, T1, + hand weeding, twice; and T4, T2 + hand weeding twice. The gross plot size was 60 x 16 m. Each treatment was replicated 5 times in 5 farmers' fields.
Observations recorded: 1, field capacity of the implements; 2, drudgery or draft; 3, weeding efficiency; 4, total energy expenditure; 5, cost of each operation for various implements; 6, cost of production; 7, gross income; 8, net income; 9, cost: benefit ratio; and 10, farmers' reaction (performance of the treatments).
Refinement of the ITK: Difficulty in the fabrication of the exact shape of *pingali dhanti* was observed while fabricating the implement. Another difficulty was the availability of a suitable size of steel flat for shanks. Hence in 2004, the shape of the shank was modified without sacrificing the effective width of the blade. The local artisans found it easy to fabricate the modified model.
Results and Discussion: The pooled results on the farmers' fields showed that there was no significant difference about field capacity and draft between the indigenous *pingali dhanti,* blade harrow and its combination with hand-weeding.

The use of *pingali dhanti* for interculture operation enhanced the productivity and net income (Rs 583/ha) compared with the interculture with traditional blade harrow (21.74 q/ha). Interculture with *pingali dhanti* along with hand-weeding gave 47% increase in net income over the blade harrow with hand-weeding (Rs 2,303/ha). To overcome the operational difficulties, the implements were operated 15 and 45 days after transplanting of tomato crop in 2002-03, and 15, 45 and be d 45 days in 2003-04 and 2004. Operation of *pingali dhanti* along with hand weeding showed higher weeding efficiency (89.53%) over interculture with *pingali dhanti* alone (65%).
Conclusion: The conclusions derived from the focus group interactions are: *pingali dhanti* has an edge over traditional blade harrow in terms of coverage, extended period of operation during the crop-growth period and efficacy in controlling weeds, ease in handling, cost effectiveness, durability, and replicability of the implement. However, blade harrow has edge over indigenous tool in terms of cost, availability, and ease in fabrication.

Use of *pingal dhanti* along with hand weeding enhanced profitability (47.1), weeding efficiency (24.53%) in rainfed tomato compared to the traditional blade harrow. It facilitated controlling weeds effectively beyond 45 days after transplanting. Farmers perceived that *pingali dhanti* has the edge over traditional blade harrow in terms of coverage, extended period of operation during crop growth period, efficiency in controlling weeds and ease in handling.

5.2. ITK: *Guddeli* to uproot ginger

Description of the ITK: Good harvest with a total recovery of ginger with less power is obtained by the use of *guddeli* at harvest. It is easy to operate and the cost of operation per hour is Rs 300. The cost of *guddeli* is Rs 60 per piece.
Location of use of the ITK: Girgitpally, mandal Vikarabad, district Ranga Reddy (Andhra Pradesh)
Experimenter: Central Research Institute for Dryland Agriculture, Hyderabad
Methodology: the place of ITK is being practiced was chosen for validation of the practice during 2002-03 and 2003-04. The farmers of the village were stratified as per the size of the land holding into marginal (< 1.0 ha), small (1-2 ha), medium (2-4 ha) and big (>4 ha). The farmers were selected by stratified random sampling, representing 10% under each category.

Focus group interactions were organized to identify the farmers to participate in the validation process voluntarily. The hand tools as per the specification of *guddeli* were fabricated with the help of local artisans. Five fanners representing different categories in each year were selected and trained to acquaint the various methodologies to implement the validation programme. Based upon the interaction of the selected farmers, an understanding was developed between the farmers and facilitators of the investigation in selection of the experimental sites, implementation of the programme and collection of the relevant data.

The critical inputs required for the investigation like hand tools and fertilizer were provided. The farmers contributed to the investigation in terms of land preparation, ginger rhizomes for transplanting, imposition of the treatments and harvesting of the experimental produce. The farmers and facilitators jointly collected the relevant data of the investigation. Each farmer was treated as a replication and statistical analysis of data for various parameters was done to find out actual effectiveness of the treatments. The parameters such as field capacity, energy expenditure and cost of operation to carry out the operation using different hand-tools were worked out based upon the formulae given below. Field capacity: It was the actual average rate of field coverage by the implement (ha/day or ha/hr.).

Energy expenditure: To obtain better carrying out rhizome planting and digging operations under each treatment were converted into energy units using standard conversion factors, and total energy expenditure per hectare was calculated. The experiment with four treatments was conducted in Girgitpally village five farmers: T1, farmers' method of planting using sickle; T2, planting with *guddeli*; T3, farmers' method of harvesting using sickle, and T4, harvesting with *guddeli.* Ginger (local variety) was taken as the test crop.

Result and Discussion: The pooled results of the 2 years revealed that the use of *guddeli* for planting significantly enhanced the field capacity (46%) and reduced the energy expenditure and cost of operation up to 28% and 19.8% respectively. Harvesting with *guddeli* gave Rs 10,274/ha increase in net income over the traditional farmers' method of harvesting with sickle. Use of *guddeli* at the time of harvesting reduced the energy expenditure (346 MJ/ha) and cost of operation (Rs 988/ha) when compared with farmers' practices.

The conclusions derived from the focus group interactions revealed that use of *guddeli* for harvesting rhizomes in ginger enhanced the net income (Rs. lO,274/ha), reduced the energy expenditure (346 MJ/ha) and cost of operation (Rs 9.88/ha) compared to the traditional sickle. But there was no significant difference between guddeli and sickle for planting in terms of cost of operations, field capacity and rhizomes yield. Farmers perceived that harvesting with *guddeli* was able to penetrate to the required depth to uproot ginger rhizomes compared to sickle.

6. Thematic areas: fishery

Table 4.7. Details of ITK on Fishery for Single Centre Experimentations

S. No.	Title of ITK	Experimenting Organization
1.	Use of banana pseudo stem in fishpond to enhance productivity of fish	West Bengal University of Animal and Fishery Sciences, Kolkata

6.1 ITK: Use of banana pseudo stem in fishpond to enhance the productivity of fish7

Description of the ITK: Pseudo stems of banana, after harvesting the bunch, are added to the pond by cutting longitudinally, which increases the pH and oxygenation of pond water. This practice increases the fish yield. As it involves low cost, it is being followed by 80% of the farmers in Bastar village of Balasore district in Orissa.

Location of use of the ITK: Village: Bastar, dist. Balasore (Orissa)

Experimenter: West Bengal University of Animal and Fishery Sciences, Kolkata 700 037 (West Bengal).

Methodology: The efficacy of banana pseudo stem for increasing the water quality of pond was evaluated by experimental methods. The experiment was conducted in village Bastar, district Balasore (Orissa). The water depth of the fishpond starts reducing and biomass of the fish gradually increases from September to May. Hence during that period there is shortage of dissolved oxygen in the pond water. The pH of the water reduces gradually and due to unfavourable condition fish starts swimming on the upper surface of the pond water in the early morning hours. If such conditions prevail for a longer period, fish starts dying. The study was conducted through field experimentation during 2002-2003 and through laboratory experiment stations during 2003-2004.

The experiment was conducted using four treatments, with three replications, viz. (i) T1, control (no treatment); (ii) T2, use of banana pseudo stem @ 2,000 kg/ha (here banana pseudo stem was allowed to decompose and disintegrate in the pond, designated ITK-1); (iii) T3, use of banana pseudo stem @ 2,000 kg/ha, (here banana pseudo stem was removed from the pond after 12-15 days of application, designated ITK-II); and (iv) T4, use of lime @ 5,000 kg/ha. Before initiation of the experiment, all ponds were treated with cow dung, urea, and single superphosphate at equal doses. IMC fingerlings of 2-3 inches size were stocked @ 5,000/ha with species combination of calla: rohu: mrigal in the ratio of 4:3:3. Duration of experiment was 10 months (September 2002 to June 2003).

Observations were taken on: (a) water-quality parameters: pH of pond water, dissolved oxygen content (ppm), total alkalinity (ppm) and total hardness (ppm); (b) growth parameters of fish: growth at harvest, yield (kg/ha), survival percentage and incidence of diseases; (c) economic parameters: total expenditure, total income and benefit cost ratio', and (d) chemical characteristics of the juice extracted from banana pseudo stem. The pond water samples were collected at monthly intervals in the early hours of the day for estimation of pH; dissolved oxygen (ppm or mg/ litre) = 0.1 x A x 1,000/ml sample, where A=volume of 0.0125 N sodium thiosulphate solution required up to end point; total alkalinity; total hardness, the mineral content in juice extracted from banana pseudo stem; and collection of fish samples for growth studies.

Conclusion: Results of the experiments show that juice of banana pseudo stem is slightly acidic in nature with high hardness and high alkalinity. It is rich in minerals like Zn, Cu, Ca, Fe, Mg, Mn, and phosphate, which slightly increased the pH, hardness, and alkalinity of water, helped precipitate the suspended matter in the water and thereby reduce the turbidity. It also increased the plankton production by facilitating the proper sunlight penetration. Fish growth in juice-treated water was higher than the control and like that of lime treatment. The ITK may be considered as a substitute for lime treatment for freshwater aquaculture.

7. Thematic area: veterinary science and animal husbandry

Table 4.8. Details of ITK on Veterinary Science and Animal Husbandry for Single Centre Experimentations

S. No.	Title of ITK	Experimenting Organization

1.	Treatment of hemorrhagic septicemia by kala jeera	Central Institute for Research on Goat, Makhdoom

7.1 ITK: Treatment of *Hemorrhagic septicemia* by *kalajeera*

Description of the ITK: Paste of *kalajeera* is applied on the throat of an HS-affected animal. The climate is semi-arid, hot, and sub-humid, suitable for the occurrence of hemorrhagic septicemia in large ruminants. Animal husbandry is a supporting business to native farmers along with agricultural farming, by keeping 3-6 buffaloes. They were fully aware of this disease in large animals, its clinical symptoms, efforts, and conventional therapy.

Location of use of the ITK: Many villages of Badaun and Bareilly districts of Uttar Pradesh

Experimenter: Central Institute for Research on Goats (CIRG), Mathura, Uttar Pradesh

Methodology: *Kalajeera* powder (100 g) is mixed in jaggery or water to make a paste, and applied on swollen throat area to treat *Haemorrhage septicaemia* in animals.

Extract of *kalajeera* (*Vernonia anthelmintica*) was prepared in different solvents, viz. chloroform, acetone, benzene, methanol, ethanol, and ether, by using Soxhlet extraction assembly. Besides, hot aqueous extract was also prepared with reflux method to study antibiotic profile under *in-vitro* drug-sensitivity test. Different concentrations of these extracts, ranging between 32,16,8,4 and 2 mg were prepared and absorbed over sterile disc with all sterile precautions.

The Muller-Hinton plates were prepared, and their sterility was checked. Pasteurella multocida B:2 culture was poured over the plates and excess growth was removed. The kala jeera extract absorbed discs were placed over these media plates, along with the control discs. The plates were incubated at 37°C and the zones of inhibition against Pasteurella multocida B:2 strain of each extract at different concentrations were recorded.

Result and Discussion: Appropriate Phytochemical study, In-vitro antimicrobial study, Clinical study was conducted in detail.

Conclusion: The *in-vitro* antibiogram study and *in vivo* clinical studies in field, showed that application of paste of kala jeera (*Veronina anthelmintica*) on swollen throat area in *Haemorrhagic septicaemia* (HS) disease in buffaloes acted as adjunct therapy along with conventionally antibacterial treatment. It helped in speedy recovery from the disease. The ITK, which has been claimed by the discloser, proved scientifically good in clinical management of HS in buffaloes.

B. Cross-sectoral ITKs for validation in more than one location in different zones (25):

Thematic areas covered:

1) Rainwater Management
2) Pest and Disease Management
3) Horticultural Crops
4) Veterinary Science and Animal Husbandry

1. Thematic area: rainwater management

Table 4.9. Details 0f ITKs on Rainwater Management for More Than One Location in Different Zones

S. No.	Title of ITK	Experimenting Organization
1	Rainwater management for teak (Tectona grandis Linn. F.), mango (*Mangifera indica Linn.*) and neem	1) Tamil Nadu Agricultural University, Coimbatore

	(*Azadirachta indica A. Juss.*) in arid and semi-arid regions	2) Central Research Institute for Dryland Agriculture, Hyderabad

The results of the experimentation including the identification of active ingredients are given below:

1.1. ITK: Rain-water management for teak (*Tectona grandis* Linn, f.), mango (*Mangifera indica* Linn.) and neem (*Azadirachta indica* A. Juss) in arid and semi-arid regions

Description of the ITK: This practice is to retain rainwater in soil and to grow trees, mainly mango, neem and teak, which are best suited for semi-arid regions. A circle in the soil is made around 1-year-old teak trees within 30 cm. and alalonga the circle's of 7.5 cm depth is made. During the first year, at the time of the rainy season, rainwater gets collected in these holes. When the tree is 2 years old, a circle can be made at 1.2 m along with 1.8 m deep holes on the circle. A similar circle at 1.8 m can be made when the tree is 3 years old along with 2.7 m deep holes on the circle to retain water in the successive year. There is no practical risk, and it is easy to handle, less labour intensive and best suited for such trees. This technique may be adopted in areas with less water available in arid and semi-arid regions.

Location of use of the ITK: Periakovilankulam, Sankararkovil (P.O.), Tirunelveli district (Tamil Nadu) 627 953

Experimenter: Forest College and Research Institute, Mettupalayam, Coimbatore, Tamil Nadu; and Central Research Institute for Dryland Agriculture, Hyderabad, Andhra Pradesh

Methodology: An unstructured interview was conducted to obtain the details of the ITK before conducting the experiment. The experiment was laid out at Forest Research College, Mettupalayam (Tamil Nadu) for 3 years (2002-2004) for trees of teak, mango, and neem to assess the effect of soil moisture-conservation practices by making micro-depressions around the basin of the plant (ITK method). This was compared with the conventional basin method for the first and second years. Mulching with pebbles was introduced to the above-mentioned two treatments during the third year. As a part of cross-validation, the experiments were conducted at Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad with grass mulch in 3 years old mango trees and teak during third year 2004.

Experiment Teak and Neem at Mettupalayam: The experimental plot was of 0.25 acres with a slope of about 4.2%. Seedlings were planted during the rainy season. Six micro-depressions (ITK), of 15-20 cm depth, were made as a circle 30 cm away from the plant stem in the first year, in the second year six more micro-depressions 30 cm away from the first circle, falling in the middle of two micro depressions of the first circle.

Mango: The ITK practice was implemented for the planted mango trees and six micro depressions were made 1 m away from the tree, in a circle, and a second circle was also made similarly. The soils of the study area are clay loam with pH 7.9 and EC 0.166 d's/m, with organic carbon content 0.51%.

Treatments: There were four treatments, T1, micro depressions (Fig. 1); T2, basin method; T3, micro depression with pebble mulch and T4, basin method with pebble mulch. Moisture content in the soil was determined using a neutron probe at three places (S1, S2, S3) up to four depths (15 cm, 30 cm, 45 cm, 60 cm). Soil moisture (% by volume) was recorded near the plant stem (S1), 30 cm away from the micro depression (S2) and again 30 cm away from the S2 (S3) at 3 spots for each depth and up to 60 cm soil depth for six trees (replications).

Soil analysis: Soil samples were collected at the top and bottom of the experimental fields (0-30 cm depth) in different years and the samples were analyzed for pH, EC and plant nutrients like nitrogen, phosphorus, potassium, and organic carbon.

Run-off studies: to evaluate the quantum of run-off water collected from the experimental plot under different treatments as micro depression (T1) and control (T2), the SCS curve number method was adopted. The equation for quantifying run-off is as follows:

$$Q = \frac{0.3S)^2}{(1+0.7S)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

Where, Q = Run-off volume (mm) , I = Rainfall (mm), S = Retention parameter

The retention parameter is defined in terms of curve number (CN):

$$S = \frac{1000}{CN} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots - 10$$

Curve number (CN) is defined as the approximate percentage of incident rainfall that becomes run-off. The curve number depends upon the land use, soil type and hydrologic condition. It was arrived at by working out the proportion of land area that offers interception to the run-off water. To estimate run-off, rainfall of 6 mm and above was taken for calculation.

Biometric observations: like height of the plant (cm) and collar diameter (cm) were recorded. Hyderabad The experiment was conducted at CRIDA, Hyderabad during 2004 with teak and mango trees.

Conclusion: The micro-depressions were useful for light showers with less intensity as in Mettupalayam because the depressions held more moisture than the basin method. More moisture can be conserved with micro depressions especially on mulching. The main disadvantage of pebble mulch is that the soil temperature tends to be higher in the summer months compared with other treatments. This may have its impact on the roots at the top.

Fig 4.1. Before Rain: Micro-depressions **Basin with grass mulch**

Fig 4.2 After Rain: Basin with grass mulch **Micro-depressions**

In slopy lands, the method of micro-depressions has its' limitations, because soil fills the micro depressions regularly during each rain. The advantage of the micro-depression method is that it can retain the soil transported by erosion in the run-off water, by collecting in the micro depressions. The micro-depression-method has been found to intercept more run-off water compared with basin method. This method has been found to be useful where trees are grown under rain-fed conditions. The growth of the trees is faster, as evident from the observations on collar diameter and height of the plants, due to more moisture availability in clay loam soils at Mettupalayam. Soil fertility tends to improve in plots where micro-depressions were made at Mettupalayam.

The effect of micro-depressions was not visible in the light soils of Hyderabad because the splash of rain caused filling of the micro depressions with sand, leaving it ineffective compared with basin method.

2. Thematic areas: pest and disease management

Table 4.10. Details 0f ITKs on Pest and Disease Management for More than One Location in Different Zones

S. No.	Title of ITK	Experimenting Organization
1.	Control of caseworm (*Nymphula depunctalis*) in rice by leaves of *parsa* and *sali*	1.Bidhan Chandra Krishi Vishwavidyalaya, Nadia 2.Birsa Agricultural University, Ranch
2.	Control of gall fly (*Pachydiplosis oryzae*) in rice	1.Bidhan Chandra Krishi Vishwavidyalaya, Nadia 2.Birsa Agricultural University, Ranchi
3.	Management of yellow stem borer in paddy by use of *parasi* {*Cleistanthus collinus*) leaf	1.Central Rice Research Institute, Cuttack, (Orissa) 2.Kalyan KVK, Purulia (West Bengal)
4.	Management of *gundhi* (harmfull green algae) in paddy field by *karada* (*Cleistanthus collinus*) leave	1.Orissa University of Agriculture and Technology, Bhubaneshwar (Orissa), 2.Central Rice Research Institute, (Orissa)

2.1. ITK: Control of caseworm (*Nymphula depunctalis*) in rice by leaves of *parsa* and *sali*

Description of ITK: Caseworms are very common in Khaspokharia village West Singhbhum district, Jharkhand. Fresh leaves of *parasi*, *Cleistanthus collinus* and sali (*Boswellia serrata*) are spread on the insect-infested field @ 5 kg leaves per 100 m2. Most insects (70-80%) are controlled with this practice.

Location of use of the ITK: Village Khaspokharia, block Tantnagar, West Singhbhum (Jharkhand)

Experimenter: Birsa Agricultural University, Ranchi (Jharkhand), and Bidhan Chandra Krishi Vishwavidyalaya, West Bengal

Methodology: Initially the experiment was conducted in farmers' fields at Khaspokharia village, Tantanagar block in West Singhbhum district of Jharkhand during 2003-04 and in 2004-05 cropping seasons. The experiment was also conducted at Central Research Farm, BCKVV, Gayeshpur, Nadia (West Bengal) during 2004-05 for cross-validation of the results obtained at Khaspokharia village. Field experiments At Khaspokharia village: the experiment was carried out in randomized block design (RBD) with four treatments in 15 replications to validate ITK. The treatments were: T1, control; T2, application of *parsa* leaves @ 100 kg/ha; T3, application of *sali* leaves @ 100 kg/ha; and T4, application of chlorpyriphos @ 1.0 litre/ha. Each farmer represented one replication with four plots and four treatments. Each plot size was within the range of 500-1000 m2. Observations were taken on number of total leaves, damaged leaves, and number of caseworm leaves/hill after 30 and 60 days of treatment (DAT). Rice seeds of local varieties were used. About 30-35-day-old seedlings were transplanted in the field.

At Central Research Farm, BCKV also, the experiment was conducted following RBD with 4 treatments each, being replicated 7 times for the control of rice caseworm. The treatments were: T1, *parasi* leaves @ 100 kg/ha; T2, *sali* leaves @ 100 kg/ha; T3, chlorpyriphos at 0.05% a. i., and T4, control. Thirty-day-old seedlings of rice variety IET 4786 (Shatabdi) were transplanted on 27 July 2004 in plots measuring 5 x 3 m at 20 x 15 cm spacing. The crop was manured with N: P: K @ 80: 50: 50. Irrigation was done as and when required to maintain standing water in the field. Fresh *parasi* and *sali* leaves were spread over the standing water in plots at 7 DAT (days after transplanting). Chlorpyriphos was sprayed twice, at 7 and 22 DAT. Observations were taken from all the hills of 0.5 m2 area at two locations in each plot at 15-day interval starting from 15 days after treatment. Counts were taken on total number of leaves in each hill and those showing infestation by caseworm. The number of leaf cases bearing larvae was also counted.

Results and Discussion: At 30 DAT minimum mean caseworm infestation (30.9%) was recorded in T4, *i.e.*, application of chlorpyriphos @ 1.0 litre/ha compared with 81.3% in control during two cropping seasons (2003-04 and 2004-05). Treatment T4 was followed by application of *parasi* leaves @ 100 kg/ha (T2,), which recorded 58.1% caseworm infestation. Data revealed that all the treatments were significantly superior to control. All the treatments were significantly superior to control. Maximum extent of control of caseworm infestation (61.53%) was recorded by application of chemical insecticide (T4). This treatment (T4) was followed by T2 (28.64%) and T3 (18.84%) at 30 DAT. Similar results were recorded at 60 DAT.

Use of parasi: leaves was effective in reducing caseworm population at 30 and 60 DAT during 2003-04 and 2004-05 cropping seasons. The maximum extent of caseworm population control (91%) and (97.5%) was recorded by the application of chemical insecticide (T4) at 30 DAT and 60 DAT. This treatment (T4) was followed by T2 (application of *parasi* leaves @ 100 kg/ha), which recorded 83.0 and 88.1% caseworm population control at 30 and 60 DAT respectively.

At Central research Farm, BCKV, Gayashpur, the caseworm infestation was low during the season. Infestation started about 10 days after transplanting of the crop, and a relatively higher level of infestation was recorded at 3 weeks after transplanting. The low level of infestation continued till 5 weeks after transplanting, after which the infestation was totally seized. Only a few scattered leaf cases containing larvae were recorded on the plots during different observations. The percentage of leaves that showed caseworm damage as recorded after 3 weeks of transplanting was 3.16% in chlorpyriphos, 4.69% in

parasi, 5.76% in *sali* and 7.52% in untreated control. Amongst different treatments, chlorpyriphos (0.05%) was superior to all other treatments. *Parasi* and *sali* were at par but only the former (*parasa)* differed significantly from the control.

Conclusion: The study revealed that spreading of *parasi* leaves once 5-10 days after transplanting @ 100 kg/ha helped in reducing both the rice caseworm infestation and larvae population. Application of *parasi* leaves showed significantly lower infestation of caseworm than control.

2.2 ITK: Control of gallfly (*Pachydiplosis oryzae*) in rice

Description of the ITK: Gallfly, *Pachydiplosis oryzae* is very harmful to rice crops. It damages the whole crop of rice. Farmers of Tamar block of Ranchi district in Jharkhand use *parso* or *persu*, *Cleistanthus collinus* leaves for controlling gallfly. In this practice, fresh leaves of *parsu* or *persu* are collected and spread in the infested field without processing. About 10 kg leaves are required for 100 m2 area. These leaves are spread at the initial stage of infestation. This practice controls 70-80% of insects. All the farmers of the village use this age-old practice.

Location of use of the ITK: Village Deori, block Tamar, Ranchi (Jharkhand)

Experimenters: *Birsa* Agricultural University, Kanke, Ranchi (Jharkhand): and Bidhan Chandra Krishi Vishvavidyalaya, Mohanpur, Nadia (West Bengal)

Methodology: Initially the experiment was conducted in village Deori, block Tamar, Ranchi (Jharkhand) during kharif 2003-2004, where results have been published in Validation of Indigenous Technical Knowledge in Agriculture Document 3 (2004). The experiment was repeated during kharif 2004-2005 at the exact location. It was also conducted for cross-validation during kharif 2004 at Central Research Farm of BCKV, Gayeshpur, Nadia, West Bengal.

Experiment: The field experiment was conducted in rainy (*kharif*) season of 2003-04 at Deori village in randomized block design with three treatments, viz., T1, control; T2, *parso* leaf @ 25 kg/ha; and T3, application of carbofuran 3 G @ 15 kg/ha (two doses), having 10 replications. Each treatment covered 2,000 m2. Observations were taken on number of tillers/m2, affected tillers/ m2, infestation (%), and extent of control. During kharif 2004-05, 10 replications were made with four treatments, viz. control, application of *parso* leaf @ 50 kg/ha, application of *parso* leaf @ 100 kg/ha and application of carbofuran @ 30 kg/ha. The changes in treatment were made to identify effective dose for control of gallfly.

The experiment conducted at Central Research Farm, BCKV had seven replications with three treatments, viz., control, application of *parso* leaf @ 100 kg/ha and application of carbofuran @ 0.75 kg a.i./ha. About 30-day-old seedlings of rice variety IET 4786 (Shatabdi) were transplanted on 27 July 2004 in plots measuring 5 x 3 m at a 20 x 15 cm spacing. The crop was manured with N: P: K @ 80:50:50. Gallfly infestation was first recorded on the crop at 35 days after transplanting and only single application of the treatments was done at 40 days after transplanting of seedlings.

The number of gallfly-infested tillers (silver shoots) was recorded from all the hills of 0.5 m2 area from two locations per plot. The number of tillers was also recorded. The plots were observed regularly at 10 days interval starting from 15 days after transplanting (DAT) for the presence of silver shoots. The infestation was first observed on 35 DAT and treatments were given on 40 DAT, the last observation was taken on 60 DAT.

Conclusion: Results of the experiments, conducted both at Ranchi and Nadia revealed that application of *parso* leaves effectively reduces the damage caused by gallfly in rice. Application of *parso* leaves @ 100 kg/ha was more effective at Ranchi. Although *parso* leaf reduced the number of silver shoots in rice in Nadia, it was not reflected in the grain yield, because the incidence of gallfly was below the economic threshold limit. The effectiveness of *parso* leaf application was like the application of carbofuran at both the locations.

2.3 ITK: Management of yellow stem borer in paddy by use of *parasi, Cleistanthus collinus* leaf

Description of the ITK: Application of 75-150 kg parasi (*Cleistanthus collinus*) leaves by broadcasting once in the rice field at 3 days after transplanting controls yellow stem-borer during kharif. The yellow stem-borer of paddy (attacking in all the growth stages, except flowering and onward stages) is the most important and major pest problem in lowland paddy. The larva enters the stem and feeds upon the internal plant material, disrupting the vascular passage to the terminal portion (leaf or panicle). It results into drying of the portion causing the symptoms (dead heart at the vegetative stage and white ear head in the mature stage)

Location of use of the ITK: All the rice growers of Aralkocha, Rahemda, Siju, Arujnjora, Chirumarcha, Hura, Piruzia villages of Purulia district, West Bengal

Experimenter: Central Rice Research Institute, Cuttack Central Rice Research Institute, Cuttack (Orissa) and Kalyan KVK, Purulia (West Bengal)

Experiment: Experiments were conducted during rainy season (*kharif*) of 2002,2003 and 2004 and during winter season (*rabi*) 2004 at Central Rice Research Institute, Cuttack and during kharif 2002 and 2003 in farmers' fields of Aralcocha village, Purulia district to validate the efficacy of *parasi* leaf against yellow stem-borer (YSB) in rice. The treatments taken during the experiment of CRRI farm were: (i) use of *parasi* (75 kg/ha) at 30 days after transplanting (DAT), (ii) use of *parasi* (75 kg/ha) each at 30,60 and 90 DAT, (iii) use of *parasi* (100 kg/ha) at 30 DAT, (iv) use of *parasi* (100 kg/ ha) each at 30, 60 and 90 DAT, (v) use of *parasi* (150 kg/ha) at 30 DAT, (vi) use of *parasi* (150 kg/ ha) each at 30, 60 and 90 DAT, (vii) use of carbofuran (1 kg/ha) at 60 and 90 DAT, and (viii) untreated control. Seedlings of Savitri variety at 30 days were transplanted during third week of July in randomized block design by using 4 replications. Observations on dead-heart (DH) and white ear formation (WEH) were taken.

Conclusion: *Parasi* leaf was found to be effective in controlling yellow stem-borer and thereby increasing rice yield when applied thrice in rice fields. It has also been found effective in increasing the population of earthworms and soil bacteria.

2.4. ITK: Management of *gundhi* (harmfull green algae) in paddy field by *karada* (*Cleistanthus collinus*) leave

Description of the ITK: *Gundhi* (Chard) which occurs in *kharif* paddy fields in stagnant water, can be controlled by broadcasting 50-100 kg freshly plucked *karada* leaves in August. The algae consume oxygen from water in rice field and produces carbon dioxide, which results in yellowing and dwarfing of rice plants. The toxicants present in *karada* leaves damage chlorophyll of green algae.

Location of use of the ITK: Panipila village of Nayagarh district in Orissa

Experimenter: Orissa University of Agriculture and Technology, Bhubaneshwar (Orissa), and Central Rice Research Institute, Cuttack (Orissa)

Methodology: *Gundhi* was found to be *Chara* (Division Charophyata, Class Charophyceae, Order Charaleas, Family Characeae). In some places *Nitella* spp. was found along with it. The algae occur in kharif paddy field during August-September in stagnant water. Cham omits foul smell, for which it is known as *gundhi*.

Experiments were conducted during the rainy (kharif) seasons of 2002,2003 and 2004 both at the farmers' fields as well as in controlled condition in the net house of CRRI, Cuttack to validate the efficacy of *karada* against *gundhi*. At CRRI, two sets of experiments were conducted, i.e., one with five replications with three treatments, viz., application of *karada* leaf @ 350 kg/ha: application of copper sulphate @0.5 g/ replication and untreated control in CRD. Cv Durga was used in the experiment.

Karada was applied twice at *gundhi* population of 50 g/ replication. Observations were taken after 20 days of each application. Another set of experiments consisted of a series of doses ranging from 1 to 5 g leaf samples of *karada* applied to the 45 days old potted plants of variety Durga with 50 g Chara in each replication with a total number of three replications. Untreated plants with Chara were considered as the control. At farmers' fields the experiment was conducted in 10 replications in CRD with three treatments, viz. application of *karada* leaf @ 350 kg/ha: application of copper sulphate @ 100 g/ha and untreated control. *Karada* was applied twice, i.e., at *gundhi* population of 1.5 and 2 kg/ha. Observations were taken after 20 days of each application. Some physiological and biochemical aspects of the *karada* leaf were studied during 2004 to work out its mode of action, which include measuring the amount of dissolved oxygen through oxygen electrode and analysis of content of chlorophyll in *gundhi* after *karada* treatment @ 350 kg/ha (5g leaves/test tray, each with 250 g *gundhi*). The quantity of phenol present in 5 g leaf sample was also analysed.

Results and Discussion: *Gund*hi was identified to be *Chara* and *Nitella spp.*, both present in their vegetative as well as mature stages. In the vegetative stage, they were green and filament type. With the increase of water depth, they also grew like cushions around the rice plant. But when the water level receded, these filaments concentrated to form a layer towards the base of the rice plant and finally remained on the soil. Both the stages gave a very foul smell.

Results from both the sets of experiment, *i.e.*, at CRRI and farmers' fields revealed that though one application of *karada* leaves reduced the population to below 50% level, another application was needed after 20 days of first application to make the rice plants completely free from *gundhi*. Copper sulphate treatment was not found to be very effective, because the water level was more, and the remaining algae multiplied after the first application. Results of the experiment conducted at CRRI during 2002 showed that reduced Chara was associated with increasing dose (1-5 g) of *karada* and with time. Reduction of Chara was found to be 20% at 3 g leaf treatment, which increased to 40% with application of 5 g at 15 DAT at maturity stage. The vegetative stage of *gundhi* was reduced 100% at 5 g and by 85% in 3 g leaf treatment. *Gundhi* released in glass jars disintegrated, including the control. But *gundhi* established itself in potted plants of rice. It showed reduction of *gundhi* at maturity stage by 20% at 3 g leaf treatment, which increased to 40% in 5 g at 15 DAT. But the vegetative stage of *gundhi* was reduced by 100% in 5 g and by 85% in 3 g leaf treatment. Results also clearly showed a gradual decrease of dissolved oxygen as well as chlorophyll content in Chara after *karada* leaf application. The oxygen content varied from 9.8 mg/litre on the first day of treatment (DAT) to 0.7 rug/litre on 4 DAT. Similarly, the chlorophyll content also showed reduction from 1.83 mg/g fresh weight of algae on first DAT to 0. 33 mg on 4 DAT (Table 3). Biochemical analysis revealed high phenol content of *karada* leaves, which was 16.4 mg/g fresh weight in comparison with 2.3-2.4 mg in rice leaf. Perhaps this high phenol content is responsible for killing *gundhi* so effectively.

Conclusion: *Karada* leaf proved effective in controlling *Chara spp* due to its efficacy in reducing the chlorophyll content in Chara, which may be attributed to high phenol content in *karada* leaf. Applying *karada* at the vegetative stage of Chara was relatively more effective.

3. Thematic areas: Horticultural crops

Table 4.11. Details of ITKs on Pest and Disease Management of Horticultural Crops for More than One Location in Different Zones

S. No.	Title of ITK	Experimenting Organization

1.	Pest management in tomato (Lycopersicon esculentum) by using leaf extract of *Cynodon dactylon*	1.Tamil Nadu Agricultural University, Coimbatore 2. Indian Institute of Horticultural Research, Bangalore (Karnataka)
2.	Control of insects in cucurbits, cowpea, and lady's finger by spraying urine of domestic animals mixed with tobacco-soaked water	1.Bidhan Chandra Krishi Vishwa Vidyalaya, Nadia 2. Birsa Agricultural University, Ranchi, Jharkhand. 3. Orissa University of Agriculture and Technology, Bhubaneshwar, Orissa 4. Central Tuber Crops Research Institute, Regional Centre, Bhubaneshwar, Orissa
3.	Control of insect-pests by spraying of starch, animal urine and dusting of cow dung ash in vegetable	1.Bidhan Chandra Krishi Vishwa Vidyalaya, Nadia. 2. Birsa Agricultural University, Ranch, Jharkhand 3. Orissa University of Agriculture and Technology, Bhubaneshwar, Orissa
4.	Protection of cabbage from pests	1.Himachal Pradesh University, Shimla, Himachal Pradesh 2.Indian Institute of Horticultural Research, Bangalore, Karnataka
5.	Use of kochila (Strychnos nux-vomica)-mixed cowdung compost in brinjal for controlling fruit and shoot borer	1.OUAT, Bhubaneshwar, Orissa 2.BCKV, Mohanpur (West Bengal); 3.Central Tuber Crops Research Institute, Regional Centre, Bhubaneshwar (Orissa)

3.1. ITK: Pest management in tomato (*Lycopersicon esculentum)* by using leaf extract of *Cynodon dactylon*

Description of the ITK: Cynodon leaf extract only applies to tomato PKM, 1 (local variety) in Karikuttanoor village, district Dharmapuri. Fresh leaves of *Cynodon dactylon* (*doob* in Hindi, *arugampul* in Tamil) are dried in shade, powdered, mixed with water, placed in an air-tight mud pot, and left undisturbed for 24 hr. This mixture is filtered twice, first using gunny cloth and then with a white cloth. Then 1 litre of this mixture is added to 1 litre water, which is sprayed using either a hand-sprayer or a power sprayer. When tomato seedling is 15 days old, this mixture can be sprayed at frequent intervals until harvest. For 1 acre of land, 10 litres of this solution are recommended. Control of root rot and damping will result in good yield. It is best suited only for tomato PKM 1 in Thaipattam (January).

Location of use of the ITK: Karikuttanoor, Thirumalvadi, Palacode, Dharmapuri (Tamil Nadu)

Experimenters: Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu) and Indian Institute of Horticultural Research, Bangalore (Karnataka)

Methodology: The study was conducted at Tamil Nadu Agricultural University, Coimbatore and Indian Institute of Horticultural Research, Bangalore.

Field experiment was conducted during 2002-03,2003-04 and 2004-05 with 3 treatments, viz. (i) *Cynodon dactylon* extract spray, (ii) endosulfan 35 EC 0.07% spray, and (iii) untreated check. Tomato (variety PKM 1) was raised in 45 m2 plots in 8 replications. Incidence of pest and yield were recorded.

Preparation of Cynodon decoction: Fresh leaves of *Cynodon* were sun dried and powdered. Then 2 kg powder is mixed with 10 litres water in a mud pot and is left for 24 hr. Filtrate obtained is diluted with equal quantity of water and sprayed at 15 days interval until harvest.

Replications: Dates of sowing: 10 April 2004, Date of transplanting 17 May 2004, Date of spray 2 July, 16 July, and 2 Aug 2004. The transplanting was delayed for 10 days due to continuous rain; hence, the farmers could not prepare the land.

Date of harvest: 30 August 2004, the observations recorded were pre- and post-treatment counts of the larvae per 20 plants on 20 DAT (days after transplanting) and fruit damage, incidence of wilt, leaf curl and fruit rot at 10 days interval from 45 days after transplanting and yield per plot (kg). Apart from this, laboratory experimentation was also done. Observations were recorded on the number of larvae of *Helicoverpa armigera*/20 plants, fruit damage, incidence of wilt, leaf curl and fruit-rot diseases.

The field experiment was repeated in Coimbatore and Bangalore. The results in both the cases showed that endosulfan at 0.07% was effective against fruit borer. *Cynodon* extract spray was not effective compared with endosulfan treatment. But the pooled results indicate that there was some reduction of fruit-borer incidence due to spraying of *Cynodon dactylon* extract. In disease management, Cynodon dactylon extract was ineffective in managing wilt, leaf curl and fruit-root disease. The component of *Cynodon* extract did not show anti-fungal activity in the TLC bioassy carried out in the laboratory. But it had shown reduction of disease compared with uncontrolled chamber.

Conclusion: *Cynodon dactylon* extract was ineffective compared with 0.05% endosulfan spray in controlling fruit borer. But *Cynodon* had some effect in reducing the fruit-borer-incidence. In disease management *Cynodon dactylon* extract showed reduction compared with untreated control.

3.2. ITK: Control of insects in cucurbits, cowpea, and lady's finger by spraying urine of domestic animals mixed with tobacco-soaked water.

Description of the ITK: Insect on leaves and fruits of cucurbits, cowpea and lady's finger are very common. These are controlled by spraying urine of domestic animals mixed with tobacco-soaked water. This age-old practice has been adopted by 56% farmers in Bahadurpur village of Dhanbad district of Jharkhand.

Location of use of the ITK: Village Bhadurpur, post-Bagsuma, block Govindpur, Dhanbad (Jharkhand)

Experimenters: BAU, Ranchi; OUAT, Bhubaneshwar (Orissa); BCKV, Nadia (West Bengal); and Central Tuber Crops Research Institute, Regional Centre, Bhubaneshwar, Orissa

Methodology: Experiments were taken up in farmers' fields, research stations, or institutes. During 2003-04 and 2004- 05 validation of field experiments were taken up in the farmers' fields with three treatments on cucurbits, cowpea, and lady's finger. The treatments were: T1, control; T2, use of animal urine mixed with tobacco-soaked water @ 25 kg tobacco stalk soaked in water and mixed with 500 litres animal urine/ha; and T3, application of monocrotophos @ 1.0 litre/ha. Observations were recorded on number of infested fruits and extent of control. During 2004 field experimentations were undertaken for cross-sectoral revalidation of the ITK practice comprising same treatments as field validation, and in-vitro studies were also taken up at OUAT, Bhubaneshwar (Orissa); BCKV, Nadia (West Bengal); and BAU, Ranchi. The invitro studies were taken up at CTCRI, Regional Station, Bhubaneshwar (Orissa). Observations were recorded on crop insect infestation, yield, additional return, and cost: benefit under different treatments.

Result and Discussion: The results were pooled of the effects of different treatments on control of insects- pests, yield and additional return for cucurbits, cowpea and okra. In cowpea spraying by insecticide (tobacco+ cow urine mixture) effectively reduced the incidence of fruit borer (8.75 to 14.94%), though the chemical insecticide was most effective. The highest fruit yield (53 to 131 q/ha) was recorded by chemical insecticide, followed by ITK method (51.4 to 105.6 q/ha). These two treatments were superior to control in all cases.

In cucurbits, the application of chemical insecticide and ITK method were more effective in controlling pod borers than the control. At BCKV, West Bengal the chemical treatment and ITK method were at par. In cucurbits the chemical control was most effective, followed by ITK method in all the cases.

In-vitro studies on the effect of cow urine mixed with tobacco-soaked water and chemical control on the mortality of insect pests of cucurbits, cowpea and lady's finger was done at Regional Center of CTCRI at Bhubneshwar. The in vitro bioassay tests revealed that the cow-urine mixed with tobacco-soaked water was equally effective in slowing the knock-down effect and mortality of *Helicoverpa armigera* on bitter gourd, and lady's finger and *Agyrthosiphum pisum* on cowpea. When compared with the systemic insecticide application, both insecticide and the ITK methods showed very high knock-down effect of the pest, showing some active principles involved in showing the effect. Tobacco leaves contain nicotine in different forms, and it acts systemically on insects, which proved harmful to many insect pests of different crops. The nicotine in tobacco and some compounds in cow urine showed synergistic effect on the mortality of the pest. The results are substantially superior to the control.

Conclusion: Using animal urine mixed with tobacco-soaked water effectively controlled major pests in lady's finger, cucurbits, and cowpea. The economic return from ITK is also higher, but not more than from chemical control.

3.3. ITK: Control of insect-pests by spraying starch, animal urine and dusting of cow dung ash in vegetables and dusting of cow dung ash in vegetables

Description of the ITK: The sticky nature of starch and uric acid of animal urine helps kill the insects. Dusting of cow dung ash helps control the biting and chewing types of insects, especially aphids. Rice starch and animal urine are sprayed on vegetable plants. These traditional practices are adopted by 85% of farmers in Kurchi village of Dhanbad district in Jharkhand.

Location of use of the ITK: Village Kurchi, block Govindpur, dist. Dhanbad (Jharkhand)

Experimenters: BAU, Jharkhand; OUAT, Bhubaneshwar, Orissa; and BCKV Mohanpur, Nadia (West Bengal).

Methodology: Experiments were conducted at Kharkotoli and Hisalpuri in Jharkand, OUAT Bhubneshwar, and Central Research Farm. BCKVV, W.B. The design was R.B.D. with 10 replications. There were three treatments, viz. T1, control, T2, spraying of animal urine mixed with starch, followed by dusting of cow dung ash (@ 500 litres of animal urine mixed with 5 litres rice starch followed by dusting of 40 kg cow dung ash/ha) and T3, application of monocrotophos @ 1 litre/ ha. The treatments were imposed on tomato and lady's finger at BAU, Ranchi and lady's finger at OUAT, Bhubaneswar and bitter gourd and brinjal at BCKVV, W.B.

Results and Discussion: The results presented show that in tomato the application of insecticide was more effective than ITK, but ITK was better than the control. The fruit yield observed at BAU, Ranchi was maximum (205.29 q/ha) in insecticide application than the other treatments. In lady's finger, insecticide spray was more effective than the other treatments, but ITK was better than control in reducing the insect pest. All the treatments

were ineffective in bitter gourd. A similar trend was observed by OUAT, Bhubaneswar at BCKVV, W.B. The yield of bitter gourd was very poor due to the attack of fruit fly and epilachana beetle. But ITK method was more effective to control the insect pests in brinjal and gave highest yield (113.30 q/ha), followed by chemical insecticide (105.59 q/ha) and control (97.27 q/ha).

Conclusion: Spraying of animal urine mixed with starch followed by dusting of cow dung ash to control major insect pests in tomato and lady's finger was effective, compared to control but the application of insecticide was more effective than ITK at BAU, Ranchi. In brinjal the ITK method was more effective than that of chemical insecticide. However, no treatment was found effective in bitter gourd.

3.4 ITK: Protection of cabbage from pests

Description of the ITK: Cabbage is one of the necessary cash crops of Shimla district. In cabbage plants a special type of pest spoils the inner portion of cabbage, the cabbage remains loose, and ultimately the plant falls. Ash and cow urine are used to protect cabbage plants from insect pests. This ITK is useful to check insect pests and to enhance cabbage productivity. Cow urine may have the same chemical that may have insecticidal properties.

Location of ITK use: This ITK is prevalent in Theog area of Shimla district in Himachal Pradesh. This area forms a part of high hills temperate wet Himalayan region and lies between the longitudes 77°-0" and 78°-19" east and latitudes 3O°-45" and 31 °-44". This zone is physiographically a mountainous tract with terraces. Mainly dry farming is practiced, and soil is shallow, silt to loam in texture and acidic in nature. This zone at present contributes to about 96% of the total temperate fruit production. Apple is the most predominant fruit grown in the zone.

Experimenters: Himachal Pradesh University, Shimla; and Indian Institute of Horticultural Research, Bangalore.

Methodology: During 2004 at MRDA farm station, Shimla cabbage aphids were collected for carrying out bioassay test and were recorded in petri-dishes at ambient room temperature and relative humidity and fed on fresh cabbage leaves in Entomology laboratory of HPU. Aphids were groomed and sprayed with 1 ml of each concentration of the stock solutions (94 ml/ 100 ml water) for insecticidal treatments of phenol, cathnol, 2,5 di phenyl phenol, paracresol, ammonia, urea, and uric acid. The treated insects were transferred to separate specimen tubes.

Mortality counts were taken for an hour after the treatment. The moribund insects were also counted as dead. The data were statistically analyzed by applying analysis of variance and the LD5 values were calculated by using the probit analysis.

Bangalore: During *kharif* 2004 the ITK was revalidated experimentally at IIHR, Bangalore where only cow urine and cow dung ash were tested for their efficacy in reducing the insect pests. Cabbage F hybrid Krishna was planted on 30 May 2004 in plots of 3x3 m with a total cabbage plant population of 24 per plot. On the same day of planting 3 litres fresh cow urine was collected in an earthen pot and buried near the experimental plot for 1 month. 100 ml of the buried and waine fresh cow urine were tested for their total nitrogen, total protein and albumin at the National Institute of Animal Nutrition and Physiology, Bangalore. Cow dung ash was obtained by burning dried cow dung. Fresh urine was brought for spray and used on the day of the treatments. The treatments were: spray of old cow urine and fresh urine at 10, 20 and 30% density, cow dung ash @ 50, 100 and 150 g/plant, sprays of standard insecticides (dimethoate 30 EC@ 2ml/litre to control aphid and the untreated check.

The treatments were given thrice, i.e., first on 10 June 2004 when the cabbage plants were having 4-5 leaves and the second on 20 June 2004, i.e., 10 days after the first spray.

Observations on the incidence of insect pests were taken up just before the first and second treatments on the same dates. Subsequently four observations were taken at 10 days interval. For these 10 plants from each plot were selected randomly and observed carefully for the pests.

On 30 July 2004, the incidence of the cocoons of the larvae parasitoid of diamondback moth, *Costesia plutellæ* was also taken. The observation on the incidence of a major pest, stem-borer, causing aborted head formation was taken on 26 June 2004. For this all the plans in each plot were observed and the incidence percentage was worked out. The toxicity data were also taken and calculated. Cabbage was harvested on 19 August 2004 and the number of healthy cabbage damaged due to insect pest was counted plot-wise and percentage marketable heads was worked out plot wise. The experiment was conducted in RBD.

Conclusion: The results of the study conducted in Himachal Pradesh during 2002 showed that cow urine treatments are effective in controlling aphid in cabbage. Application of cow dung ash and fresh urine treatments took a little longer time for pest eradication than the aged urine. The treatments with cow urine (30 and 100% concentration) were more effective than those of 10 and 20% respectively. All the urine types (cow, buffalo, and sheep), whether fresh or aged, showed nearly similar effects for similar concentration levels without any significant difference. Treatments with 150 g ash per plant were most effective compared with other quantities used and neither cattle urine nor cow dung ash showed any marked effect on the growth of cabbage plant. However, the results of the study conducted at IIHR, Bangalore revealed that the ITK could have been more effective in reducing the aphid population in cabbage, the effect being inconsistent and sporadic perhaps due to receipt of continuous rains during growth period of crop.

3.5. ITK: Use of *kochila* (*Strychnos nux-vomica*)-mixed cowdung compost in brinjal for controlling fruit and shoot borer

Description of the ITK: Cowdung, 10 kg *kochila* (*Strychnos nux-vomica*) seed powder and 25 kg kochila leaf are put in a compost pit of 10x3x3 feet by mixing thoroughly. Then 10 litres cow urine is added to the pit for 10 consecutive days and covered with soil. After 2 months the compost becomes ready. This compost (5 g) is added to each plant once at the time of sowing and at 45 days after planting. Due to its repellent action, incidence of shoot and fruit borer is reduced.

Location of use of the ITK: Badakodanda, Bhanjanagar. Ganjam (Orissa)

Experimenters: *1.* OUAT, Bhubaneshwar, Orissa; BCKV, Mohanpur (West Bengal); and Central Tuber Crops Research Institute, Regional Centre, Bhubaneshwar, Orissa)

Methodology: The efficacy of kochila-mixed cowdung compost for controlling fruit and shoot borer was evaluated by participatory rural appraisal (PRA), field survey and experimental methods. OUAT conducted the experiment at two sites at (i) Badakodanda village, and (ii) KVK, Bhanjanagar, with three treatments: (i) mochila-mixed cowdung compost applied @ 5 g/plant at planting and @ 10 g/plant after 45 days of transplanting (ITK method); (ii) chemical pesticide (granular) at planting @ 10 kg *a.i.*/ha, 15 days after transplanting, Nukil 60 days after transplanting and Sevin-75 days after transplanting; and (iii) without any treatment (control).

The experiment was laid out in CRD with 15 replications. The variety used was Bhanjanagar Local. Observations were taken on: (i) percentage of shoot infestation; (ii) percentage of fruit infestation; (iii) fruit weight; (iv) number of fruits/ plants; (v) yield of fruits/plant; (vi) fruit taste; (vii) fruit yield/ha; and (viii) marketable fruit yield. The experiment conducted in 2002-03 was repeated in the village Badakodanda during 2003- 04 following the same package of practices. BCKV conducted the experiment in 2004. Fruit

borer in brinjal additional treatment was imposed with tobacco-soaked water, whereas the three other treatments were the same as that of OUAT. Bioassay of decoction was done at Regional Station of Central Tuber Crops Research Institute, Bhubaneshwar.

Results and Discussion: During 2003-04 the overall fruit and shoot-borer incidence was less compared with 2002-03 but the trend was maintained in both years. The pooled results revealed that with the use of kochila enriched cowdung the incidence was reduced in shoot and fruit borer by 3.92 and 4.89% respectively. The effect of kochila compost was at par with the pesticide for fruits/plant, yield of fruits/plant, number of fruits/plant and total fruit yield. At BCKV, all the treatments effectively controlled shoot infestation by fruit and shoot borer (Table 2). Based on average percentage of damaged shoots, the chemical (5.48%). This treatment though differed significantly from the chemical treatment was at par with kochila compost. The ITK treatment of kochila cow dung compost although recorded much better and superior performance but was less effective than the pesticide application remaining almost at par. Hence, owing to the fact that the pesticides applied to the crop have residual effects on the fruits and responsible for health hazards, the ITK practice may be preferred. Moreover, the yield per plant and yield per ha under ITK treatment and pesticide schedule treatment in both years showed similar trends. Bioassay (in-vitro) of kochila-mixed cow dung compost and tobacco-soaked water was carried out on knock-down and mortality of brinjal fruit and shoot borer at Regional Centre of CTCRI, Dumduma, Bhubaneswar, (Orissa). Significant mortality was noticed in kochila mixed cowdung compost treatment when compared with control, but it was on par with treatment was found to be the best (2.53% shoot damage) followed by kochila compost (3.5% shoot damage) which were statistically at par with each other.

Conclusion: Use of kochila -mixed cowdung compost reduces the incidence of fruit and shoot borer in brinjal considerably, which also matches with the claim of the discloser. The mixture of tobacco-soaked water with soap was effective in controlling fruit and shoot borer but not as that of kochila-mixed cowdung compost. Results revealed that kochila-mixed with cowdung compost used by farmers through generations would be promising for controlling fruit and shoot borer in brinjal.

4. Thematic areas: veterinary science and animal husbandry

Table 4.12. Details 0f ITKs on Veterinary Science and Animal Husbandry for More than One Location in Different Zones

S. No.	Title of ITK	Experimenting Organization
1.	Treatment of foot-and-mouth disease in cattle by using *harida* (*Terminalia chebula*] and b*ehada* (*Terminalia bellirica*)	1.Birsa Agricultural University (BAU), (Jharkhand) 2.West Bengal University of Animal and Fishery Sciences (WBUAFS), Kolkata, West Bengal 3.Orissa University of Agriculture and Technology (OUAT), Bhubaneswar, Orissa
2.	Evaluation of peach (*Prunus persica*) leaves with fresh milk in the treatment of FMD lesion/wound	1.Indian Veterinary Research Institute (IVRI), Izatnagar, 2.Govind Ballabh Pant University of Agriculture and Technology (GBPUAT), Pantnagar
3.	Use of *babool* (*Acacia nilotica*) and *jamun* (*Syzygiune cumini*) bark	1.Indian Veterinary Research Institute (IVRI) Izatnagar 2.IVRI, Mukteswar, Nainital

	extract to cure foot-and-mouth disease in animals	3. Birsa Agricultural University (BAU) Ranchi 4.West Bengal University of Animal and Fishery Sciences (WBUAFS), Kolkata
4.	Use of *bantulsi* (*Ocimum gratessimum*) leaf paste for treatment of *khurha* (FMD) in cattle and buffalo	1. Indian Veterinary Research Institute (IVRI) Izatnagar; 2. Indian Veterinary Research Institute (IVRI) Mukteswar 3.West Bengal University of Animal Sciences and Fishery Sciences (WBUAFS), Kolkata
5.	Use of stone fruit (*bael*) to check diarrhoea in animals	1 Indian Veterinary Research Institute (IVRI), Izatnagar, 2.Govind Ballabh Pant University of Agriculture and Technology (GBPUAT) Pantnagar, 3. Maharashtra Animal Science & Fisheries Sciences University (MASFSU), Nagpur (Maharashtra)
6.	Control of diarrhoea in cattle and buffalo a paste made from leaves of *shisham* (*Dalbergia sissoo*)	1.Indian Veterinary Research Institute (IVRI) Izatnagar, 2.Gobind Ballabh Pant University of Agriculture and Technology (GBPUAT) (Uttaranchal); 3.Maharashtra Animal Science and Fisheries Sciences University (MASFU), Nagpur, (Maharashtra); 3.Birsa Agricultural University (BAU) Ranchi
7.	Treatment of diarrhoea by juice of *urhul* (*Hibiscus rosasinensis*) flower in goat	1. Maharashtra Animal Science and Fishery Sciences University, Nagpur 2. Central Institute for Research on Goats (CIRG), Mathura
8.	Treatment of diarrhoea in animals (goat and sheep) by *pojo*	1. Birsa Agricultural University (BAU), Ranchi (Jharkhand) 2. Central Institute of Research on Goats (CIRG) CIRG, Mathura
9.	Curing of diarrhoea in goats by using takala {Cassia tora) flower juice	1.Maharashtra Animal Science and Fisheries Science University (MASFSU), Nagpur 2.Central Institute for Research on Goats (CIRG) Makhdoom, Mathura
10.	Wound management in animal by use of leaf extract of ridge gourd (*Luffa accutangula*) /ekdandi (*Tridax procumbents*)	1.Maharashtra Animal Science and Fishery Sciences University (MASFSU) 2.Ch. Sarwan Kumar, Krishi Vishwavidyalaya (CSKHPKV), Palampur
11.	Use of *bhangariya* (*Eclipta alba*) to cure blain in animals	1. Maharashtra Animal Science and Fishery Sciences University, (MASFSU) 2. Tamil Nadu Veterinary and Animal Sciences University, Chennai
12.	Treatment of swelling of shoulders in bullocks/bull	1. Indian Veterinary Research Institute, Izatnagar

		2. Maharashtra Animal Science and Fishery Sciences University, Nagpur
13.	Technique of curing bone fracture in animals	1.Ch. Sarwan Kumar Krishi Vishwavidyalaya, Palampur 2. Birsa Agricultural University, Ranchi
14.	Determination of efficacy of pigeon waste in showing estrus symptoms in heifers	1.Indian Veterinary Research Institute (IVRI); 2.Govind Ballabh Pant University of Agriculture and Technology (GBPUAT)

4.1. ITK: Treatment of foot-and-mouth disease in cattle by using *harida* (*Terminalia chebula*) and *baheda* (*Terminalia bellirica*).

Description of the ITK: FMD is a deadly viral cattle disease, causing severe mouth and foot lesions. The oral mucosa and dorsum of the tongue are severely affected and there is sloughing of the mucous layer of oral cavity as well as dorsal aspect of the tongue, for which animal cannot eat. Similarly, development of severe lesions in the interdigital clefts of the four legs are seen, due to which the affected animals cannot walk properly. Ultimately, milk yield in cattle decreases abruptly and the bullocks cannot perform properly. There is severe deterioration of health and body conditions. Foot-and-mouth disease (FMD) in cattle is treated by applying to the affected parts with 500 g each of *harida* and *behada* powder mixed with 2,500 ml water, twice a day, after boiling.

Location of ITK use: Cattle owners in Makarbili village of Nawapada district in Orissa.

Experimenters:

1) Veterinary College, Birsa Agricultural University (BAU), (Jharkhand)
2) West Bengal University of Animal and Fishery Sciences (WBUAFS), Kolkata, West Bengal
3) Veterinary College, Orissa University of Agriculture and Technology (OUAT), Bhubaneswar, Orissa

Methodology:

Experiment BAU: The seeds of *harida* and *baheda* were collected locally and crushed to make a powder. Then 250 g of each of *harida* and *baheda* powder mixed with 1 litre of water and boiled to make a good paste. This paste was applied on foot lesions twice daily for 7 days after thorough washing. The experimentation on animals was done on 20 types of wounds. All the wounds were free of maggots (either the maggots were removed earlier or were not found). The wounds are evaluated on days 0, 2, 4, 6, 8, 10, 12 and 14 to see the recovery.

WBUAFS Clinical trial: The trial was conducted in 10 clinical cases of FMD. The dried fruits of *harida* and *baheda* were crushed thoroughly in a grinding stone separately. Fine powder was prepared and 500 g of each of them was mixed with 2.5 litres water and boiled for 30 min. After boiling, the mixed pasty preparation was kept overnight and cooled. This herbal ITK paste thus intramuscularly daily for 3 days). The foot-and mouth lesions were washed with 1% potassium permanganate solution twice daily. Boroglycerine was applied on mouth lesions and Himax ointment was applied on foot lesions after washing. The healing of lesions was assessed based on colour of wound, quantity and type of exudation and pain on a scale of 0-4.

OUAT: To manage foot and mouth disease in cattle, 500 g each of *harida* and *baheda* seed powder was mixed with 2.5 lit water and applied twice a day after boiling. A total of 12 cattle affected with FMD were randomly selected for the study and divided into 2 groups. The animals of the first group were treated with ITK. Animals of the second group received conventional allopathic veterinary medicines administered Enrofloxacin (10%) injection

after washing the lesions with potassium permanganate or Povidone iodine. Boroglycerine was applied on the mouth lesions in the conventional treatment group. A group of 12 cattle was treated with conventional therapy, comprising of an antibiotic (Moxel @ 2-3 g intramuscularly daily for 4 days) and an analgesic (Butagesic @ 10 ml.

Results and Discussion: The animals treated with *harida* and *baheda* paste at BAU recovered within 6-7 days, but foot lesions took 17-18 days to complete cure. In allopathic treatment the initial improvement was noticed, although the wound complications persisted. In the ITK-treated group, peripheral swelling, warmness and pain were reduced in 3-4 days. The clinical improvement was markedly significant in ITK treatment compared to allopathic treatment. The treatment of FMD foot lesions with *harida* and *baheda* paste was more cost effective than allopathic treatment. The health improvement was better than in allopathic-treated animals in the later phase of the disease. At WBUAFS the application of the ITK comprising *harida* and *baheda* resulted in recovery of foot lesions within 12 to 13 days. However, the conventional veterinary treatment resulted in recovery from foot-and-mouth lesions within 6 to 7 days. Wound exudation, pain and lameness decreased in both the treated groups 4 days after treatment. The ITK proved effective in management of foot lesions in FMD though at lower efficacy than the conventional treatment.

Histopathological study: This experiment was conducted to find cellular evidence of wound healing, which was assessed by histopathological studies in 30 rabbits, divided into two groups (Group I and Group II). The wounds of the control group (G I) were washed with normal saline only, and in Gr II, were treated with the pasted of *harida* and *baheda.* The biopsy material was collected from both the groups at 4-day intervals. The samples were preserved in 10% neutral buffer formalin, and routine histological technique was adopted using H &E method.

On day 4, the histological examination in both the groups revealed severe inflammation, marked by presence of severe lymphocytic infiltrations and of sero-fibrinous exudates. On day 8 the histological examination in the treated group showed some evidence of regenerating epidermis and thin layer of dermis along with randomly arranged fibroblast and neovascularization. But in the control group there was no evidence of regeneration of the epidermal layer. *On day 12*, the dermis foundation was completed and a thin layer of epidermis with a few epidermal pegs having tendency to move towards the centre was noted. But in the control group the dermal layer was still in the process of regeneration and there was no evidence of epidermis. Based on all the histopathological studies findings, wound healing was accelerated by topical use of *harida* and *baheda* in the treated group.

Results at OUAT showed that in animals treated with powder of *harida* and *baheda* mixed with water, the hoof lesions were cured within 10-11 days. All other parameters were found to have improved. Animals of Group 2 treated with antibiotic and antiseptic recovered within 5-6 days.

Conclusion: The ITK consisting of use of paste prepared from seeds of *harida* and *baheda* was validated at Veterinary colleges BAU, WBUAFS and OUAT. The practice proved effective in management of foot lesions in FMD, albeit at lower efficacy than the conventional treatment. Histo-pathological findings showed that wound healing was accelerated by topical use of *harida* and *baheda,* which could be responsible for efficacy of ITK.

4.2. ITK: Curing lesions of FMD or wounds by applying extract of peach (*Prunus persica*) leaves mixed with fresh milk

Description of the ITK: To treat the lesions of mouth and hooves of the animals suffering from FMD, extract of peach leaves mixed with fresh milk is applied three times daily on

the lesions of FMD-affected parts of the animals. This is followed in many villages of Budaun, Shahjahanpur and Bareilly districts of Uttar Pradesh.

Location of use of the ITK: Farmers in villages of villages of Budaun, Shahjahanpur and Bareilly districts of Uttar Pradesh

Experimenters: Indian Veterinary Research Institute (IVRI), Izatnagar, Uttar Pradesh. and Govind Ballabh Pant University of Agriculture and Technology (GBPUAT), Pantnagar

Methodology:

IVRI: Peach (*Prunus persica*) leaves were evaluated with fresh milk to treat wounds. During the period of investigation of 2004, a total of 23 maggot wounds were treated with the paste of peach (*Prunus persica*) leaves at Livestock Production Research (Cattle and Buffalo) and at veterinary polyclinics of the Institute. The cases included 17 of bovines and 6 of canines. The paste was applied on the affected part and the wound was bandaged. The wounds were evaluated on days 0,3,7,10,14 and 21 or till the healing based on the evaluation of exudation, quantity of exudates, peripheral swelling, warmth, and pain, the colour of wounds and granulation tissue.

GBPUAT: Collection and processing of peach leaves: Fresh neat and clean peach leaves were collected from the local areas and grinded to prepare paste in distilled water as and when required. Experimental animals: Cattle and buffaloes (40) having wounds on various parts of body were selected at IDF, College Veterinary Teaching Hospital, and the nearby villages were divided into two groups of maggoted and non-maggoted wounds of 20 animals each. These two groups were further subdivided into 2 subgroups for therapeutic evaluation.

Therapeutic trial: To study the comparative therapeutic efficacy, the subgroups a and b of groups I and II animals were treated as per protocol given below:

Table 4.13

Wounded animals (n=40)	
Maggoted wound (n=20)	Non-maggoted wounds (n=20)
Standard therapy (n=10)	Standard therapy (n=10)
Lorexane ointment)	(Betadine dressing + Sulprim bolus
Peach leaves paste (n=10)	Peach leaves paste (n=10)

Depending upon clinical recovery, the period of medication varied from 14 to 21 days in animals and even within a group. All the affected wounds were evaluated on days 0, 3, 7, 10, 14 and 21 or till healing occurred based on parameter given below.

Exudation: Type of exudates was scored and graded as 0= dry casts; 1= serious; 2= fibrinous; 3= seropurulent and 4= purulent.

Quantity of exudate: Quantity of exudates was scored as 0= none (apparently dry wound); 1 = slight (wound is moist but not oozing on pressing); 2= moderate (wound is moist and slightly oozing on pressing); and 3= extreme (exudate is visible and pressure leads to excessive exudation).

Peripheral swelling: Peripheral swelling was recorded at weekly intervals as- 0= nil; 1 = moderate and 2= marked. Warmth and pain: Warmth around the affected area was compared with that of the normal area of touching with palm. This was done by the same person at 10.30 a.m. The warmth was graded as per order: 1= normal warmth; 2= mild warmth; 3= moderately warmth and 4= hot. Pain on manipulation: The pain of the affected area was recorded as: 0=no pain on extensive manipulation; 1= pain on extensive manipulation; 2= pain on moderate manipulation, and 3= pain on slight manipulation. Colour of wound: It grossly depicts the healing status and was scored as: 1= pale yellow; 2= pale red and 3= Pink. Area of wound: Area of wound was recorded at 7 days intervals.

The margins of wound, area of granulation and area of epithelization were marked, and the percentage of healing was calculated. Finally, the time taken for complete healing was recorded.

Results and Discussion: Therapeutic trial: Total 23 maggot wounds (17 bovine and 6 canine) were treated at IVRI with the paste of peach (Prunus persica) leaves. In bovines 8 cases recovered by day 7 and 6 recovered on day 14. The remaining 3 cases of maggot wounds required 28 days (4 weeks) for complete recovery. It was noticed that the recovery period was longer when the site of wound was such that bandage could not be applied. In canine 3 cases recovered on day 7 but the remaining 3 recovered on day 14.

The paste of peach *leaves* was found to be very effective in the treatment of maggot wounds. One or two applications were required to kill the maggots. There was reduction in peripheral swelling, decrease in pain and warmth scores following the treatment and the healing progressed.

The type and quantity of exudate decreased after 2-3 applications. The wounds appeared dried and the peripheral swelling subsided. There was concomitant decrease in pain and warmth scores. As the healing progressed, the colour of wounds changed from pale red to pink. Most of the wounds were healed by day 14, whereas 3 wounds required a longer period (day 28) for healing. The overall efficacy of the peach-leaf pastes in healing the wound was 47.82, 86.95 and 100% on day 7, 14 and 28 respectively, which is almost comparable to the efficacy of standard veterinary treatment. The efficacy of peach leaves may be attributable to the presence of phytochemical ingredients such as flavonoids.

At GBPUAT, a total of 8 cases of maggoted wound out of total 10 got cured by application of fresh paste of peach leaves twice for 14—21 days. However, by the standard therapy, 90% (9/10) of maggot wound were cured in 14 days. The therapeutic efficacy of peach-leaf paste in non-maggot wound was 70% in group Ila compared with 90% in standard therapy group lib.

Identification of maggots: The species of maggots were identified in 3 cases of wounds at IVRI. The maggots belonged to *Callitroga* species. The average length of maggots was 10 mm.

Ingredient analysis of peach leaves: The peach leaves were subjected to phytochemical testing and the active compounds were identified as flavonoids, alkaloids, steroids and triterpenoids, fixed oils and fats, tannins, and phenolic compounds.

Conclusion: The peach leaves were found effective for treating maggot wounds. One or two applications were required to kill or expel the maggots. The paste was applied on the affected part and bandaged. After 2-3 applications the type and quantity of exudates decreased. The wounds appeared dried and the peripheral swelling subsided. Healing of the maggot wounds took longer time where bandaging was not possible. The efficacy of ITK may be attributable to presence of active ingredients such as flavonoids, steroids, fixed oils etc. Its efficacy was comparable to that of standard veterinary treatment.

4.3. ITK: Use of *babool* (*Acacia nilotica*) and jamun (*Syzygium cumini*) bark extract to cure foot-and-mouth disease in animals

Description of the ITK: A paste of *babool* bark and jamun bark is applied on the hooves of the FMD-affected animal thrice daily, costing Rs 2-5 per animal. In this method the disease is cured up to 70%

Location of ITK use: This is practiced in many villages of Baduan and Bareilly districts of Uttar Pradesh.

Experimenters: Indian Veterinary Research Institute (IVRI) Izatnagar; IVRI, Mukteswar, Nainital (Uttaranchal): Birsa Agricultural University (BAU) Ranchi (Jharkhand); and West Bengal University of Animal and Fishery Sciences (WBUAFS), Kolkata (West Bengal)

Methodology:

Experiment IVRI: Use of *babool* bark and jamun bark decoction was found highly effective in treatment of foot lesions in clinical cases of FMD during 2003. The ITK was found cost effective and had easy accessibility. Therefore, it was recommended for in-vitro antiviral activity trials.

Preparation of extracts: Aqueous extracts of *babool* and *jamun* bark were prepared per standard protocol and put to solubility test. The aqueous extracts of *babool* and *jamun* were readily dissolved in sterile distilled water. A 10 mg/ml stock of extracts was made in sterile distilled water and filtered separately using 0.22 mm filters. The filtrates were used for cytotoxicity in BHK2| and Vero cell lines.

Cytotoxicity study: Initially the following concentrations of the extracts were prepared in GMEM/EMEM with 1 % new born calf serum bovine-calf serum from the stock solutions. BHK21 or Vero cells were grown to confluence for 48 hr in 24-well plates. Then the monolayers were washed with GMEM/EMEM containing 1 % NBCS/BCS and antibiotics. Later each of the extract concentrations in GMEM/EMEM with 1% NBCS/BCS in quadruplicates was fed on to the confluent monolayer with appropriate controls. The plates were incubated at 37°C under 5% CO2 for 96 hr and up to 144 hr. The cells were observed at 24 hr intervals for cytotoxicity and the following changes were noted.

Determination of safe concentrations: Safe concentrations of the extracts were determined by using 1, 10, 100, 1,000, 2,000 and 3,000 mg/ml extract of *babool* or jamun in BHK21 cell monolayer for 96 hr. Determination of viable cells: The confluent monolayers of both BHK2| and Vero cells were treated with different concentrations (as indicated below) with appropriate controls and then incubated in an incubator at 37°C for 72 hr. under 5% CO2. After the incubation period, the cells were treated with trypsin to detach the cells from the surface and then the cells were stained with 0.4% Trypan blue.

Antiviral activity against blue-tongue virus serotype: The Vero cells were initially put for 24 hr. in a 24 well-cell culture plate (Nunc). The cells were washed with 2% EME medium. Then 100 TCID50/100 ml BTV serotype 23 was infected in duplicates and allowed to adsorb for 1 hr. The unabsorbed virus was removed by washing the cell monolayers with 2% EME medium. Further the monolayers were fed with different concentrations of *babool* (10, 40, 50 and 100 mg/ ml) and *jamun* (10, 100, 800 and 1000 mg/ml) separately with appropriate virus and cell controls. The plates were incubated in a 5% CO2 incubator at 37°C for 72 hr. and the readings were noted.

Antiviral activity against goat-pox virus (GPV): The experiment was conducted as above for GPV, *i.e.* using direct and indirect methods for all the extracts.

Conclusion: At BAU, ITK consisting of use of a decoction of *jamun and babool* bark in FMD lesion was initially validated at IVRI, Izatnagar and was reported to be highly effective in the management of foot lesions in outbreak of FMD. The ITK was cross-validated at Ranchi and Kolkata veterinary colleges. The findings from these two centres also confirmed the earlier findings that ITK is effective in management of FMD foot lesions. However, studies conducted at IVRI did not reveal any antiviral activity of either of the bark extracts against the blue-tongue virus. Rut jamun bark extract had inhibitory effects on goat-pox virus. ITK had some wound-healing as well as selective anti-viral-potential. Further studies are required to establish antiviral activities of these two bark extracts, especially against FMD virus.

4.4. ITK: Use of *bantulsi* (*Ocimum gratissimum*) leaf paste for treatment of *khurha* (FMD) in cattle and buffalo: Description of the ITK:

Description of ITK: *Bantulsi* has medicinal properties against FMD. Paste of its leaves is prepared after grinding it with water and applied on the infected foot of cattle and buffalo at least twice daily for 3-4 days. Success has been reported in more than 75% of the cases.
Location of use of the ITK: The practice is prevalent in Barmasa village of Jarmundi block in Dumka district (Jharkhand) and has potential for spread in the areas where *bantulsi* is available
Experimenters: I.V.R.I., Izatnagar; I.V.R.I., Mukteswar, dist Nainital; and West Bengal University of Animal Sciences and Fishery Sciences (WBUAFS), Kolkata.
Methodology:
Experiment IVRI: Use of *bantulsi* was found slightly effective in treatment of foot lesions in clinical cases of FMD during the validation trial conducted at Veterinary College.
BAU, Ranchi in 2003: *Preparation of extracts*: Aqueous and alcoholic extracts of *bantulsi* were prepared as per standard protocol and put to solubility test. Both the extracts readily dissolved in sterile distilled water. A 10 mg/ml stock of extracts was made in sterile distilled water and filtered separately using 0.22 mm filters. The filtrates were used for cytotoxicity in BHK2| and Vero cell lines.
Cytotoxicity study: Initially, different concentrations of the extracts were prepared in GMEM/EMEM with 1 % newborn calf serum or bovine calf serum from the stock solutions. BHK21 or Vero cells were grown to confluence for 48 hr. in 24-well plates. Then the monolayers were washed with GMEM/EMEM containing 1% V NBCS/BCS and antibiotics. Later each extract concentration in GMEM/EMEM with 1% NBCS/BCS in quadruplicates was fed on to the confluent monolayer with appropriate controls. The plates were incubated at 37°C with 5% CO2 for 96 hr. up to 144 hr. The cells were observed at 24 hr. intervals for cytotoxicity and the following changes were noted.
Determination of safe concentrations: Safe concentrations of the alcoholic and aqueous extracts of *bantulsi* were determined by using 1, 10, 100, 1,000, 2,000, 3,000 and 4,000 mg/ml in BHK2| cell monolayer for 96 hr.
Determination of viable cells: The confluent monolayers of both BHK21 and Vero cells were treated with different concentrations (indicated below) with appropriate controls and then incubated in an incubator at 37°C for 72 hr. under 5% CO2. After the incubation period, the cells were treated with trypsin to detach the cells from the surface, which were then stained with 0.4% Trypan blue. Antiviral activity against blue-tongue virus serotype: Preliminarily, the Vero cells were put for 24 hr. in a 24 well cell culture plate (Nunc). The cells were washed with 2% EME medium. Then 100 TCID5(/100 ml of OBTV serotype 23 was infected in duplicates and allowed to adsorb for 1 hr. The unabsorbed virus was removed by washing the cell monolayers with 2% EME medium. Further, the monolayers were fed with different concentrations of *bantulsi* alcoholic and aqueous extracts separately with appropriate virus and cell controls. The plates were incubated in a 5% CO2 incubator at 37°C for 72 hr. and the readings were noted. Antiviral activity against goat-pox virus: The experiment was conducted as above for GPV, i.e. using direct and indirect methods for all the extracts.
Results and Discussion: The application of the ITK comprising b*antulsi* leaf paste resulted in recovery of foot lesions within 14 to 15 days. However, the conventional veterinary treatment resulted in recovery from foot and mouth lesions within 6 to 7 days. Wound exudation, pain and lameness decreased in both the treated groups after 4 days of treatment. However, in ITK treatment group, the healing of wound lesions remained incomplete and the gait of animals showed slight lameness till the period of observation. The results indicated that ITK was moderately effective in managing foot lesions in FMD.

Conclusion: Farmers were advised to repeat the treatment in similar manner twice or thrice daily and to restrict the grazing of animals and entry into the muddy places. The animals were examined for healing of the lesion after 7 days. The extract of *bantulsi* also did not reveal antiviral activity against blue-tongue and goat-pox viruses.

4.5. ITK: Use of stone apple (*bael*) to check diarrhoea in animals

Description of the ITK: Stone apple (*bael*) might have an anti-diarrhoea ingredient. Its juice is mixed with water and drenched to the animals suffering from diarrhoea, 2-3-times a day. Treatment per animal costs Rs 15 to 20. The animal is cured in 2-3 days.

Location of use of the ITK: Animal owners of many villages in Budaun, Shahjahanpur and Bareiily

Experimenters: Indian Veterinary Research Institute (IVRI), Izatnagar, U.P.: Govind Ballabh Pant University of Agriculture and Technology (GBPUAT) Pantnagar, Uttaranchal; and Maharashtra Animal Science & Fisheries Sciences University (MASFSU), Nagpur (Maharashtra)

Methodology:

Experiment IVRI Therapeutic trials: *Bael* powder @ 24 g/100 kg body weight for 3 days was given orally to 25 clinical cases of animals suffering from neonatal diarrhoea (Gr II). The animals of Gr I (5) receiving standard treatment served as the control.

Evaluation of therapy: The diarrhoeic animals were kept under close observations and the treatment success in the two groups was evaluated on the basis of clinical and hemato-biochemical improvement

Clinical profile: The clinical scores (0-3 basis) for faecal consistency (FC), dehydration and depression were recorded on day 0 (before therapy) and days 3 and 7 after therapy as per the following criteria suggested by Walker et al. (1998).

Haemato-biochemical profile: The blood samples were collected before (day 0) and after administration of the treatment (days 3 and 7) and analyzed for different haemato-biochemical parameters, viz. packed cell volume (PCV), glucose, protein, albumin (A) and globulin (G) ratio (A:G ratio), sodium (Na), potassium (K) and chloride (Cl) following standard methods.

GBPUAT Therapeutic trials: Calves (30) suffering from diarrhoea were divided randomly into three equal groups. The animals of group I were given standard treatment in the form of Cflox-Tz bolus (ciprofloxacin + tinidazole) @ one bolus per 100 kg body weight twice a day for 3 days.

The animals of group II were treated with *bael* powder juice @ 24 g/100 kg body weight twice a day for 3 days. The animals of group 111 received CfloxTz @ one bolus/100 kg body weight twice daily and bael powder juice @ 24 g/100 kg body weight twice daily for 3 days.

Evaluation of therapy: The animals were observed closely, and different treatments' therapeutic efficacy was evaluated based on clinical profile and haemato-biochemical changes.

Clinical profile: To study the clinical profile of diarrhoeic calves, a clinical score (0-3 basis) for faecal consistency, dehydration and depression was recorded on day 0 (before treatment) and days 3 and 7 after therapy

Hemato-biochemical study: Major clinical manifestations including general appearance, status of dehydration, posture, temperature, pulse, respiration, heart rate etc. were recorded in all affected calves and the blood samples were collected for blood bio-chemicals analysis before (day 0) and after (days 3 and 7) the treatment.

Phytochemical study: The matured unripe *bael* fruits of medium size were procured from in and around Pantnagar. It's hard covering was removed and fruit was sliced and shade

dried. Subsequently, the dried slices were powdered and 24 g each was stored in polythene packets till use. Aqueous, methanolic and hexane extracts of *bael* powder were prepared and subjected to chemical analysis and through HPTLC for active ingredient analysis.

Anti-microbial activity assessment: Agar well method was used to study antimicrobial activity of *bael* powder. A concentration of 500 mg/ml extract of *bael* powder was prepared in different solvents. An amount of 150 ul/well of this concentration was used for antimicrobial assessment. Etiological investigation: To know the frequency distribution of various etiological agents, faecal samples of all the diarrhoeic calves were examined microscopically and for microbial culture and antibiotic sensitivity.

MASFSU Therapeutic trial: The study was conducted on goats presented to Veterinary College Hospital, Nagpur with a history of diarrhoea or dysentery. These goats were subjected to detailed clinical and parasitological examinations and were subdivided into parasitic and non-parasitic groups. These animals were randomly assigned to two treatments within each broad groups (parasitic and non-parasitic) comprising 6 goats irrespective of their age and sex. Medium-sized unripe bael (*Aegle marmelos*) fruit was sliced, dried and grinded to powder. The bael-fruit powder was given orally @ 1.6 g/10 kg body weight twice a day to the goats suffering from parasitic and non-parasitic diarrhoea.

Faecal sample examination: Faecal samples of goats suffering with diarrhoea were collected per-ractal in clean sterile glass vials before treatment and after that on day 6 of the treatment. The samples were examined by sedimentation technique immediately after collection. Efficacy of treatment: The efficacy of the drugs was evaluated based on eggs per gram faeces (EPG) determined by modified Stoll's dilution technique on days 0 and 6 after treatment. Clinical examination: Clinical signs such as dehydration score and faecal consistency were recorded Haemato-biochemical profile: Packed cell volume (PCV), serum total protein, albumin (A), globulin (G), A: G ratio, chloride, sodium and potassium were estimated from the blood samples collected on days 0 and 6 post-treatment.

Conclusion: The study was conducted to validate the use of *bael* fruit powder in diarrhea. The initial validation was done at IVRI, where the *bael* powder given @ 24 g/100 kg body weight orally was found to hasten the recovery in calves suffering from E. coli diarrhoea. The *bael* powder was of particular use as a supportive therapy. The cross-sectoral validation study done at Veterinary College, GBPUAT and Veterinary College, MASFSU, Nagpur confirmed these findings. The *bael* powder also showed mild anthelmintic effects and was useful in parasitic diarrhoea as well. The active ingredient study revealed the presence of alkaloids, tannins, flavonoids, saponons and triterpenes, which may be responsible for the ameliorative potential of *bael* in diarrhoea.

4.6. ITK: Control of diarrhoea in cattle and buffalo by a paste made from leaves of *shisham* (*Dalbergia sissoo*)

Description of the ITK: *Dulbergia sissoo* leaves might be having anti-diarrhoea medicinal value. This ITK is highly compatible with the existing resources. About 500 g of *shisham* leaves are ground into paste and are mixed with 1 litre water and drenched 2-3 times a day per adult cow or buffalo. It costs Rs 1-2 per animal. The animal is cured in 2-3 days.

Location of ITK use: Villages of Shahjhanpur, Bulandshar and Bareilly districts of Uttar Pradesh.

Experimenters: *Indian* Veterinary Research Institute (IVRI) Izatnagar, (U.P.); Gobind Ballabh Pant University of Agriculture and Technology (GBPUAT) (Uttaranchal); Maharashtra Animal Science and Fisheries Sciences University (MASFU), Nagpur, (Maharashtra); and Birsa Agricultural University (BAU) Ranchi (Jharkhand)

Methodology:

Experiment IVRI Therapeutic trials: *Shisham* leaf powder @ 105 g/100 kg body weight orally twice a day for 3 days was given to 25 clinical cases of animals suffering from neonatal diarrhoea (Gr II). Animals of Gr I (5) receiving standard treatment served as the control.
Evaluation of therapy: The diarrhoeic animals were kept under close observation and the treatment success in the two groups was evaluated based on clinical and haemato-biochemical improvement.
Clinical profile: The clinical scores (0-3 basis) for faecal consistency (FCS), dehydration and depression were recorded on day 0 (before therapy) and on days 3 and 7 post-therapy as per the criteria suggested by Walker et al. (1998).
Haemato-biochemical profile: The blood samples were collected before (day 0) and after administration of the treatment (days 3 and 7) and analysed for different haemato-biochemical parameters, viz. packed cell volume (PCV), glucose, protein, albumin (A) and globulin (G) ratio (A:G ratio) sodium (Na), potassium (K) and chloride (Cl) following standard methods.
Experiment GBPUAT Therapeutic trials: A total 30 clinical cases of diarrhoea were divided randomly into three equal groups. The animals of group I were given standard treatment in the form of Cflox-Tz bolus (ciprofloxacin + tinidazole) @ 1 bolus per 100 kg body weight twice a day for 3 days. The animals of group II were treated with *shisham* leaves powder @ 105 g/100 kg body weight twice a day for 3 days. The animals of group III received Cflox-Tz bolus @ 1 bolus per 100 kg body weight twice a day and shisham leaves powder @ 105 g/ 100 kg body weight twice a day for 3 days.
Evaluation of therapy: The animals were observed closely and therapeutic efficacy of different treatments was evaluated based on clinical profile and haemato-biochemical changes.
Clinical profile: To study the clinical profile of diarrhoeic calves, a clinical score (0-3 basis) for faecal consistency, dehydration and depression was recorded on day 0 (before treatment) and days 3 and 7 post-therapy, as suggested by Walker et al. (1998) and described in the report of IVRI. Major clinical manifestation, viz. general appearance, dehydration status, posture, temperature, pulse, respiration and heart rate were recorded in all affected calves before and after treatment.
Hemato-biochemical study: Blood samples from all affected calves were collected before and after treatment for blood bio-chemical parameters including PCV, glucose, total protein, albumin (A), globulin (G), A:G ratio, serum sodium, potassium and chloride.
Phytochemical analysis of shisham leaves: Cold methanolic, hexane and aqueous extracts of *shisham* leaves were prepared after soaking the powder in these solvents for 24 hr. Phytochemical analysis of these extracts was done for the presence of alkaloids, anthraquinones, flavonoids, saponins, tannins, sterols, reducing sugars, glycosides, resins, triterpenes, proteins and coumarins by the standard methods.
Antimicrobial activity assessment: Antimicrobial activity assessment of *shisham* leaf-powder extracts was assessed against commonly prevalent bacteria of enterobacteriacae using standard methods of agar wells. A concentration of 500 mg /ml extract of *shisham* leaves powder was prepared in different solvents. An amount of 150 ul/well of the above concentration was used for antimicrobial assessment.
Etiological distribution: Faecal examination of 52 calves of various age groups (1 week to 6 months) was done by standard techniques to determine the etiological agent (s) associated with the diarrhoea. The faecal samples that were negative for parasitic eggs were subjected to microbial investigation and antibiotic sensitivity tests.
MASFSU Therapeutic trial: The study was conducted on goats presented to Veterinary College Hospital, Nagpur with a history of diarrhoea or dysentery. These goats were

subjected to detailed clinical and parasitological examination and were subdivided into parasitic and non-parasitic groups. These animals were randomly assigned to two treatments within each broad groups (parasitic and non-parasitic) comprising 6 goats irrespective of their age and sex. Freshly collected *shisham* leaves were minced in a mixer and the paste was administered orally @ 25 g twice a day to goats suffering from parasitic and non-parasitic diarrhoea.

Faecal sample examination: Faecal samples from goats suffering with diarrhoea were collected per-ractal in clean sterile glass vials before treatment and thereafter on day 6 of the treatment. The samples were examined by sedimentation technique immedietly after the collection.

Efficacy of treatment: Efficacy of the drugs was evaluated on the basis of eggs per gram faeces (EPG) determined by the modified Stoll's dilution technique on days 0 and 6 post-treatment.

Clinical examination: Clinical signs such as dehydration score and faecal consistency were recorded. Haemato-biochemical profile: Packed cell volume (PCV), serum total protein, albumin (A), globulin (G), A: G ratio, chloride, sodium and potassium were estimated from the blood samples collected on days 0 and 6 post-treatment.

BAU Therapeutic trials: The clinical trial was conducted in 30 goats having parasitic and nonparasitic diarrhoea. These were divided into 3 different treatment groups, each comprising 10 animals. Group I (non-parasitic diarrhoea) was given *shisham* leaf paste orally 30 g twice daily for 3 days. Group II (parasitic diarrhoea) received Fazole – 1 /2 bolous twice a day for 3 days and Panacur @ 5 mg/kg body weight single dose. Group III (parasitic diarrhea) received *shisham* leaf paste orally @ 30 g twice daily and Panacur 5 mg/kgbody weight single dose. In severely dehydrated cases 5% dextrose was also infused.

Conclusion: Use of *shisham* leaf paste in the treatment of diarrhoea was validated initially at IVRI. It was found that *shisham* leaf paste given @ 105 g could enhance the recovery in E. coli diarrhoea. Further studies at IVRI and cross-validation at three different centers also confirmed the ameliorative potential of *shisham* leaves in different types of parasitic and non-parasitic diarrhoea. In-vitro testing revealed no antibacterial activity in aqueous extract of *shisham* leaves. The presence of alkaloids, saponins and tannins may be responsible for antidiarrheal activity of *shisham* leaves

4.7. ITK: Treatment of diarrhoea by juices of *urhul (Hibiscus rosasinensis)* flowers in goats

Description of the ITK: Diarrhoea is common in goats in Samtoli village of Simdega district in Jharkhand and is controlled by extract of *urhul* flower. Juice of *urhul* flowers (2-3 flowers) is orally administered twice a day for 3 days. The cost of the treatment is Rs 30 per animal. A majority of the farmers use this ITK in this village. About 20% goats suffer from diarrhoea, and the reported ITK treats 50%. An evergreen, woody, glabrous, showy shrub, 5-8 feet high. The flowers solitary, axillary and bell shaped. It is native of China. It is grown as an ornamental plant in gardens throughout India and often planted as hedge or fence plant

Location of use of the ITK: Samtoli, Simdega, Simdega (Jharkhand)

Experimenters: Maharashtra Animal Science and Fisheries Sciences University (MASFSU); and Central Institute for Research on Goats (CIRG), Mathura, Uttar Pradesh.

Methodology:

MASFSU: The study was conducted on goats presented to Veterinary College Hospital, Nagpur with the history of diarrhoea or dysentery. These goats were subjected to detailed clinical and parasitological examination and were sub-divided into parasitic and non-parasitic groups and were randomly assigned to two treatments within each broad groups

(parasitic and non-parasitic) comprising of 6 goats irrespective of their age and sex. Another group consisting of 6 goats was kept as the standard treatment.

Fresh flowers of *Hibiscus rosa-sinensis* were collected in the morning and minced in a mixer to make a homogeneous juice. The juice was strained through a sieve and drenched @ 15 ml twice daily to goats suffering from parasitic and non-parasitic diarrhoea.

Faecal sample examination: Faecal sample of goats suffering with diarrhoea were collected perirectal in clean sterile glass vials before treatment and thereafter on day 6 of the treatment. The samples were examined by sedimentation technique immediately after collection.

Therapeutic efficacy: The therapeutic efficacy of the drugs was evaluated on the basis of eggs per gram faeces (EPG) determined by modified Stall's dilution technique on day 0 and 6 aftertreatment.

Clinical examination: Clinical signs such as dehydration score and faecal consistency were recorded.

Haemato-biochemical profile: Packed cell volume (PCV), serum total protein, albumin (A), globulin (G), A: G ratio, chloride, sodium and potassium were estimated from the blood samples collected on day 0 and 6 after treatment.

CIRG: Therapeutic trial: Clinical trial was conducted on 15 goats suffering with diarrhoea. Only the animals found negative for endoparasitic infestation were selected. Bacteriological examination of faecal sample from representative clinical cases showed predominantly Escherichia coli. All the animals were given methanolic extract of *urhul* flowers @ 50-mg/kg body weight after preparing suspension in gum acacia (5%). This preparation was administrated once daily for 3 consecutive days. The assessment of clinical efficacy was based on revival of appetite, faecal consistency and dehydration status.

Haemato-biochemical estimation: Standard methods were used to estimate glucose, albumin, globulin, A:G ratio, aspartate amino transferase activity and creatinin, sodium, potassium and chloride concentrations in the serum samples collected before and 3 days after the treatment.

Phyto-chemical analysis: *Urhul* flowers were collected from local area of Mathura district of Uttar Pradesh and taxonomically identified as *Hibiscus rosa-sinensis*. After drying the flowers at room temperature, methanolic extract was prepared by Soxhlet assembly as per the standards techniques and concentrated by rotary evaporator.

In-vitro antimicrobial activity of juice: Antibiogram study was conducted against E. coli isolated from clinical cases by using different concentrations (1, 2, 4, 8, 16 mg/disc) of *urhal* extract. The sterile disc (Hi-media) was loaded with these dilutions individually. Control disc, loaded with solvent base was prepared separately. To compare the antimicrobial properties of various extract with commonly practiced antibiotics, antibiogram profile against 12 known antibiotics was also conducted under similar conditions using the same isolates.

Conclusion: The initial validation study using ITK (flower juice of *urhul*) for treatment of diarrhoea was conducted at Veterinary College, BAU, Ranchi. The use of *urhul*-flower juice proved effective in treatment of diarrhoea in goats. But recovery period following treatment by the ITK was more than that by the standard veterinary therapy. Further trial for cross-sectoral validation was done at Veterinary College, MASFSU Nagpur and CIRG, Makhdoom. Both studies recorded moderate degree of effectiveness of the ITK against parasitic and *E. coli* diarrhoea in goats. However, the juice did not reveal any antibacterial activity. Presence of flavonoids, tannins and alkaloids may be responsible for the efficacy of the ITK in diarrhoea.

4.8. ITK: Treatment of diarrhoea in animals with *pojo* (goats and sheep)

Description of the ITK: Goat and sheep suffering from diarrhoea are treated with *pojo* (*Litsaea anthapoly*) plant. Paste is prepared by crushing the *pojo* plants and fed to animal @ Vi cup of *pojo* paste daily for 3 days. Villagers believe that *pojo* plant has medicinal value, controls diarrhoea and prevents dehydration. This wisdom is being used for the ancient times without modification. About 40% goats suffer from diarrhoea in the village from where the ITK is reported. Out of these, 30% cases of diarrhoea are treated by the method of ITK, 5% remains untreated and some other medicines treat 5%.

Location of use of the ITK: Sose, Kanke, Ranchi (Jharkhand)

Experimenters: Birsa Agricultural University (BAU), Ranchi (Jharkhand); and Central Institute of Research on Goats (CIRG) CIRG, Makhdoom, Mathura, Uttar Pradesh.

Methodology:

BAU: *Pojo* plant bark was collected, dried and powdered by using an electrical grinder. The powder was sieved before use. The clinical trial was conducted in 30 goats having parasitic and non-parasitic diarrhoea, which were divided into 3 different treatment groups, each consisting of 10 animals.

Group I (non- parasitic diarrhoea) was given *pojo* bark powder orally @ 40 g twice daily for 3 days in the form of paste.

Group II (parasitic diarrhoea) received Fazole- Vi bolus twice a day for 3 days and Panacur @ 5 mg/kg body weight single dose.

Group III (parasitic diarrhoea) received *pojo* paste orally @40 g twice daily and Panacur 5 mg/kg body weight single dose.

CIRG: **Therapeutic trial:** In-vivo study was carried out in 15 goats suffering from non-parasitic diarrhoea. Bacteriological examination of faecal sample from representative clinical cases showed predominance of *Escherichia coli*. Goats were given extract of *pojo* bark at the dose rate of 20 mg/kg body weight. The suspension of extract was prepared in gum acacia (5%) for oral preparation, which was drenched once daily for three consecutive days. The assessment of clinical efficacy was based on revival of appetite, faecal consistency, dehydration status and changes in serum biochemical parameters, before and after treatment.

Hemato-biochemical estimation: Standard methods were used to estimate glucose, albumin, globulin, A:G ratio, aspartate aminotransferase activity, creatinin, sodium, potassium and chloride concentrations in serum samples collected before and 3 days after the treatment.

Chemical analysis: Pojo bark was collected from Ranchi (Jharkhand), where this indigenous technology was reported. The bark was completely dried, powdered and its methanolic extract was prepared with Soxhlet assembly and was subjected to phytochemical analysis. In vitro antimicrobial activity of juice: Antibiogram study was conducted against *E. coli* isolated from clinical cases of diarrhoea in goats using different concentrations (1, 2, 4, 8, 16 mg/ disc) of extract of *pojo* bark juice

Conclusion: The ITK, *i.e.*, use of *pojo* bark paste in diarrhoea, was initially validated at Veterinary College, BAU, Ranchi. The study concluded that the paste of *pojo* bark was beneficial in treating non-parasitic diarrhoea in goats. Present trial at the same centre by another scientific team reported 90% efficacy of ITK when used alone and 100% efficacy when combined with anthelmintic. The average recovery period with the ITK treatment was 3-5 days and in combination treatment 2 days. Cross-sectoral validation studies conducted at CIRG also substantiated the previous report. It was concluded that the bark of *pojo* (Litsaea anthapoly) plants had strong potential as an antidiarrhoeal herb in goats. This property may be attributed to its antibacterial activity against E. coli and possibly potentiated by its astringent action by the presence of glycosides, alkaloids and saponins

4.9. ITK: Curing of diarrhoea in goats by using *takala, Cassia tora* flower juice

Description of the ITK: Diarrhoea is a commonly observed health disorder in goats. The reason may be eating of tender grasses in rainy season, and the excess intake of tubers and grains. To control diarrhoea, *takala* flower juice and Vi cup tea are orally administered to the goat for 2-3 days.

Location of use of the ITK: Farmers of Solapur, parts of Sangli, Ahmednagar and Pune districts in Maharashtra adopted this practice since several years. Takala *(Cassia tora) a* small weed plant, an annual herb 30-90 cm high, is widely spread, growing on dry soil. It occurs in wasteland during rainy season. Leaves and seeds of *takala* are laxative, antipyretic, anthelmintic, ophthalmic and expectorant. The leaves and seeds are useful in cough, constipation and stomach disorder.

Experimenters: Maharashtra Animal Science and Fisheries Science University (MASFSU) and Central Institute for Research on Goats (CIRG) Makhdoom, Mathura (U.P.)

Methodology:

MASFSU: Therapeutic trial: The study was conducted on goats presented to Veterinary College Hospital, Nagpur with the history of diarrhoea or dysentery. These goats were subjected to detailed clinical and parasitological examinations, subdivided into parasitic and non-parasitic groups, and randomly assigned to two treatments within each broad group (parasitic and nonparasitic) comprising 6 goats irrespective of age and sex. Another group consisting of 6 goats was kept as standard treatment. Flower juice of *takala* {*Cassia tora*) was prepared by mincing freshly collected flowers of *Cassia tora* in the morning hours. The juice was strained through a sieve and drenched @ 15 ml twice daily to goats suffering from parasitic and non-parasitic diarrhoea.

Faecal sample examination: Faecal sample of goats suffering with diarrhoea was collected perrectal in clean sterile glass vials before treatment and thereafter on day 6 of treatment. The samples were examined by sedimentation technique immediately after collection.

Therapeutic efficacy of the drugs: It was evaluated based on eggs per gram faeces (EPG) determined by modified Stoll's dilution technique (Soulsby, 1982) on days 0 and 6 aftertreatment. **Clinical examination:** Clinical signs such as dehydration score and faecal consistency were recorded.

Haemato-biochemical profile: Packed cell volume (PCV), serum total protein, albumin (A), globulin (G), A: G ratio, chloride, sodium and potassium were estimated from the blood samples collected on days 0 and 6 after-treatment.

CIRG: Therapeutic trial: Therapeutic efficacy of *takala* leaf extract was carried out in 15 diarrhoeic goats. Bacteriological examination of faecal sample from representative clinical cases (10) showed predominantly *Escherichia coli.* The methanolic extract of takala leaves suspension was prepared in gum acacia (5%) for oral administration and given @ 30 mg/kg body weight, once daily for 3 consecutive days.

Haemato-biochemical estimations: Standard methods were used to estimate serum glucose, albumin, globulin, A:G ratio, aspartate amino transferase activity, creatinin, sodium, potassium and chloride concentrations in serum samples collected before and 3 days after the treatment.

Phyto-biochemical analysis: *Cassia tora* plant (leaves) was procured from Banagalore. After complete drying at room temperature, it was powdered and methanolic extract was prepared with Soxhlet assembly.

In-vitro antimicrobial activity of juice: Antibiogram of *Takala* leaves juice was determined against *E. coli* isolated from clinical cases of diarrhea in goats using different concentration (1, 2, 4, 8, 16 mg per disc)

Conclusion: The initial validation study using ITK (flower juice of *takala* in treatment of diarrhoea was conducted at Veterinary College, MASFSU, Nagpur. The findings recorded moderate degree of effectiveness of the ITK against parasitic diarrhoea in goats. Further trial at the same centre substantiated the previous year's results with additional finding on the moderate efficacy of the ITK in non- parasitic diarrhoea. Considering the nonavailability of flowers in different seasons, *takala* (*Cassia tora*) plant leaves were assessed for their efficacy against *E. coli* diarrhoea at CIRG, Makhdoom. The leaf extract showed enough potential as an antidiarhoeal therapy in management of diarrhoea in goats. This may be due to its moderate antibacterial property against *E. coli* and its astringent action due to presence of tannins and saponins besides flavonoids.

4.10. ITK: Wound management in animals by use of leaf extract of ridge gourd (*Luffa acutangula*) or *ekdandi* (*Tridex procumbens*)

Description of the ITK: This practice is followed by the farmers of semi-arid tract of western Maharashtra. Ridge gourd or *ekdandi* leaves are ground and the juice is extracted. The extracted juice is smeared over the wounds of the animal. This practice effectively controls wound in animals due to antiseptic lotion present in ridge gourd and *ekdandi* leaves.

Location of use of the ITK: Semi-arid tract of western Maharashtra specifically in parts of Pune, Satara, Solapur and Ahmednagar districts.

Experimenters: Maharashtra Animal Science and Fishery Sciences University (MASFSU); and Ch. Sarwan Kumar, Krishi Vishwavidyalaya (CSKHPKV), Palampur (Himachal Pradesh)

Methodology:

Experiment MASFSU: Preparation of juice: The fresh leaves of ridge gourd and *ekdandi* were collected from the vicinity of Cattle Breeding Farm, Nagpur and adjoining villages of Nagpur district. The leaves of both plants were washed with distilled water 2 to 3 times and triturated in grinder-cum-mixer separately to form a paste. The paste was squeezed with muslin cloth to obtain juice extract.

Preparation of aqueous extract: The fresh leaves of each herb were washed with 0.2% mercuric chloride in distilled water for 2 min. followed by five to six washings with distilled water. Fresh leaf extract, viz. cold-water extract of fresh leaves, hot water extract of fresh leaves, cold water extract of dried leaves and hot water extract of dried leaves of ridge gourd and *ekdandi*, were prepared as per the standard method prescribed by Omoregbe etal. (1996) to evaluate the *in-vitro* antibacterial activity. Total 30 clinical cases of wounds in buffaloes of either sex and in the age group of 1 to 3 years were randomly subjected to the following three treatment groups consisting of 10 wounds in each group. The wounds were treated at the door step of farmers in Nagpur and adjoining areas. All the wounds were cleaned with moist sterile gauze before application of respective medicament. A sterile gauze soaked in juice was placed on the wounds after gentle squeezing in order to keep the juice in contact with tissue of wound. The juice of ridge gourd and *ekdandi* leaves and Neosporin ointment were applied once a day to treat the wound till healing.

Clinical observation: The wounds in each treatment group were subjected for gross examination (type of wound: fresh or contaminated, presence of discharges like blood, exudates, pus), appearance of granulation tissue, wound contraction (the percentage of wound contraction was calculated at days 0, 3, 6, 9, 12, 15,18 and 21), number of days required for healing and extent of cicatrisation (the cicatrix contraction was assessed on the basis of size of wound on 0 day and then subsequently on every third day up to complete cicatrix formation).

The mapping of wound was done with the help of filter-paper by pressing over the wound and moist-area impression was measured by using vernier calipers. The data pertaining to

wound size in all the treatment groups at different period intervals were statistically analyzed by two-way analysis with multiple observations.

Histomorphological study: The biopsy sample of the tissues was collected on days 7, 14 and 21 after-treatment and subjected to standard procedure of fixing and staining the tissue for recording the histo-morphological changes during the wound healing process. In vitro evaluation of antibacterial activity: Various extracts were evaluated for their antibacterial spectrum against indicator organisms such as *Staphylococcus aureus*, *Statphylococcus epidermidis*, *Streptococcus spp.*, *Pseudomonas aeruginosa*, *Proteus spp. and E. coli using* diffusion assay method.

CSKHPKV: The study was conducted during 2004 on 10- 12 months old healthy male calves (9) that were acclimatized to college animal shed for at least 21 days before start of trials. All the animals were subjected to routine clinical, haematological and faecal examinations to ensure their health status. The animals were dewormed with bolus Fentas (fenbendazole) @ 7.5 mg/kg body weight 15 days before start of experiment. All the animals were kept in similar managemental conditions throughout the study.

The animals were divided into 3 equal groups, viz. groups A, B and C, for conducting wound-healing study. For creation of wounds, thoraco-lumbar region of each animal was prepared for aseptic surgery. Six equidimensional (3 cm x 3 cm), full-thickness excisional cutaneous wounds, 3 on either side of the vertebral column and 3 cm apart on the dorsal aspect of thoracolumbar region were created under local infiltration anaesthesia. The animals of group A served as negative control, in which the wounds were dressed with normal saline-soaked gauze. The animals of group B served as positive control, in which 5% Povidone iodine suspension was used as a dressing agent. The wounds of group C animals were treated with topical application of fresh juice of ridge gourd leaves extracted immediately before each application.

The wounds were dressed daily for 14 days and on alternate days subsequently. Evaluation of healing of wound: Heart rate, rectal temperature and respiration rate were recorded on days 3, 7, 14, 21 and 28 postoperatively and compared within and between the groups. The wounds were also examined to record the degree of inflammation, exudation, underlying tissue-healing changes, granulation tissue formation and percentage of wound contraction. The percentage wound contraction was measured using the formula:

$$\text{Wound Contraction (\%)} = \frac{A-B}{A} \times 100$$

where, A = is area (cm2) of the wound at day 0, and B = area (cm2) of the wound at day 3, 7, 14,21 and 28.

Conclusion: The percentage of wound contraction was more than 32% on day 12 after treatment in the wounds treated with juice of ridge gourd and *ekdandi* leaves compared with only 18.50% in Neosporin-treatment group, indicating early process of wound healing. The histomorphological findings revealed early keratinization of dermal epithelium in both the groups of wounds treated with juice of ridge gourd and *ekdandi* leaves on day 21 after treatment. However, the keratinization of dermis was not evident of the wounds treated with Neosporin ointment, which indicated better healing property of these herbs. The juice of ridge gourd and *ekdandi* fresh leaves as well as cold and hot water extracts of fresh leaves of ridge gourd possessed anti-bacterial activity. It was concluded that ridge gourd can be used effectively for treating the wounds contaminated by *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Pseudomonas aeruginosa* and *E. coli*. The use of ridge gourd (*Luffa acutangula*) extract was also found safe for topical application on cutaneous wounds and was useful in the treatment of excisional cutaneous wounds in animals

4.11. ITK: Use of *bhangariya (Eclipta alba)* to cure blain in animals.

Description of the ITK: To cure the animals from blain, farmers use paste of *bhangariya*. About 200-250 g of *bhangariya* plant (leaf and stem) is collected from the field and washed before crushing. The paste is fried in 50-60 ml mustard oil. The fried paste is divided into three parts, which are used in 3 days after changing the old doses. This practice controls 80-90% of the problem for cattle, buffaloes and goats. Out of 1,200 farmers, 400-500 farmers follow this practice.

Location of use of the ITK: Sonapur, Johanaganj, Azamgarh districts of Uttar Pradesh

Experimenters: Maharashtra Animal Sciences and Fishery Sciences University (MASFSU) Maharashtra; and Tamil Nadu Veterinary and Animal Sciences University (TANUVAS) Tamil Nadu.

Methodology:

Experiment MASFSU: Preparation of poultice: The fresh leaves and stem part of *bhangariya* plant was triturated in the mortar. The poultice so obtained was fried with mustard oil and stored in bottle and was used for application on local inflammatory swellings as and when required.

Treatment with poultice: Thirty cases of local inflammatory swellings on any part of body irrespective of species were identified. Their initial inflammation was recorded with the help of vernier calipers. The poultice of *bhangariya* prepared earlier (approximately 250 g) kept on cotton, was applied on the inflammatory swellings in 20 cases. The bandage was applied on the affected part. The poultice of *bhangariya* was kept in contact with the affected part for 5 days and maximum up to 9 days or till the inflammatory swelling subsided. After removal of poultice, the diameter of inflammatory swelling was again measured with vernier calipers. The difference in the diameter of inflammation before and after treatment was recorded and the data were analysed statistically by Students' 't' test to test the significance level. The remaining 10 cases of inflammatory swelling were treated with iodine ointment as standard veterinary ointment and same procedure was repeated.

The difference in diameter of inflammation observed in two different treatments, i.e., *bhangariya* poultice and iodine ointment, were compared with each other for their efficacy and analysed by Students 't' test.

TANUVAS: To study the effect of *bhangariya (Eclipta alba)* on blain in animals, 22 cases were selected for the study. These animals included 2 calves, 7 horses, 3 bullocks, 2 cows, 4 buffaloes and 4 goats. The cases included joint swelling, yoke swelling, swelling of neck region, polyarthritis, thelitis, capped knee, saddle gall, polyarthritis without navel ill, contusion pelvis and orchitis. The inflammatory signs like rubor, callor, dollor, tumour and functionalasia were studied before and periodically during the treatment. They were graded as normal, mild, moderate and severe and very severe; each grade was scored as 0, 1, 2, 3 and 4 respectively

Conclusion: Results obtained at MASFSU indicated that the leaves and stem of *bhangariya* plant possess some active principles (ecliptene, wedelollactone and sterols, reported earlier) which is anti-inflammatory. Hence, the poultice of leaves and stem of *bhangariya* plant fried in mustard oil effectively managed the blain in buffaloes. The *bhangariya* poultice was equally effective to that of iodine ointment to manage the blain in farm animals. The paste of *Eclipta alba* is effective in muscular and not in skeletal affections, as found from the results obtained at TANUVAS. The results further revealed its positive effect in soft tissue swellings, especially in cases of thelitis in buffaloes, which has economic consequences if treatment is delayed. The paste of *Eclipta alba* is cost-effective compared with conventional therapy. It was inferred that the paste of *Eclipta alba* was effective in the management of soft tissue swelling in animals in a cost-effective manner.

4.12. ITK: Treatment of swelling of shoulders in bullocks or bulls

Description of the ITK: Bullocks cannot do work when shoulders are swollen. A mixture of *geru* (30 g) and snail shell or *sipi* (50 g) is boiled in castor oil. *Alua* (20 g) and *kudru* or *sahjan* gum (50 g) are mixed to it. This paste under warm condition is applied on the affected swollen neck of the animal. This condition is generally seen in draught animals. The bullocks are generally affected and the condition is known as yoke gall. The cases are generally seen in areas where bullock carts are used for transportation of goods. Continuous chronic irritation results in painful swelling and wounds at shoulder. As shown in Fig. 1, inappropriate size of animals in a pair used for draught or agricultural operations also leads to this disease. The ITK is practised , particularly where bullock carts are used extensively for rural transport and agriculture is dependent on bullocks

Location of use of the ITK: This is practiced by the villagers of Nayabas Kutubpur in Bulandshahr district of Uttar Pradesh.

Experimenters: Indian Veterinary Research Institute, Izatnagar (Uttar Pradesh); and Maharashtra Animal Science and Fishery Sciences University (MASFSU) Nagpur (Maharashtra).

Methodology: The ITK was validated at IVRI, Izatnagar and at MASFSU, Nagpur for cross-sectoral revalidation during 2004.

Experiment IVRI: During 2004, 16 clinical cases which included 6 bovines (shoulder swelling 1, joint and limb swellings 5) and 10 equines (joint and limb swellings 10) were used. Of 5 bovine cases of joint and limb swelling, 3 were of calves having swelling at carpal joint of these, 2 cases had hard and painful swelling.

X-ray examination revealed osteoarthritis and animals showed severe lameness. In one calf the swelling was soft with mild pain. The remaining 2 bovines were adult. One animal was buffalo bullock having severe lameness and swelling at fetlock. Treated horses had swelling at elbow, fetlock, chronic tendosynovitis and arthritis of fetlock and carpal joint.

A mixture of powder of snail skull 10 g, alua 10 g, sahjan gum 10 g and geru 30 g was mixed in 150 g castor oil. This paste was heated and after cooling at warm stage was applied on the affected part twice or thrice a day. For shoulder swelling, swelling pain by pressing at the site and side effects, if any, on days 0, 7, 14, 21 and 30 were recorded. In contrast, for joints and limb swelling, swelling, pain at the site, weight bearing in standing position, weight bearing in motion and side effects, if any, were recorded on days 0, 7, 14 and 21. The pain sensation was judged based on pressing of the swelling site with thumb and finger and was graded as 0= no pain, 1= mild pain, 2- moderate pain and 3= severe pain on days 0, 7, 14, 21 and 30. The observations regarding the weight bearing in standing position was recorded in groups III and IV and graded as 0= no weight bearing, 1= toe touching the ground, 2= moderate weight bearing and 3=full weight bearing.

Weight bearing in motion was assessed in groups III and IV and graded as 0= support the limb on the ground and put less weight, 1= moderate weight bearing with limping, 2=full weight bearing but lame and 3=full weight bearing without lameness.

Conclusion: The ITK preparation consisting of geru 30 g, snail shell powder 50 g boiled in castor oil. Alua 20 g and kudru or sahajan gum 50 g and proprietary preparation—iodine ointment was found effective in the treatment of swelling of neck or shoulder and limb or joint in bullocks and bulls. There was decrease in swelling and pain scores of joints and limb at different time intervals after commencement of treatment using ITK. Of the 16 animals, 8 recovered completely, whereas in spite of reduction in pain and swelling, the rest of the animals did not show complete recovery, especially those having osteoarthritis and chronic capped elbow. The findings at both the centres validated the efficacy of ITK in treatment of swelling of shoulder and joints in animals.

4.13. ITK: Technique of curing bone fracture in animals

Description of the ITK: *Harjore* is a perennial climber, used in the treatment of bone fracture in animals as well as in human being. Paste is prepared by crushing the *harjore* plant and it is applied on the fracture part which is then tied along with sticks. At every 3 days interval it is replaced by fresh *harjore* paste and this process is continued 2 to 3 times. *Harjore*, a climber having fleshy stone and quadrangular stem is found throughout the hotter parts of India and Sri Lanka

Location of use of the ITK: This practice is being used by the villagers of Samtoli village of Simdega district in Jharkhand for the last many years

Experimenters: Birsa Agricultural University, Ranchi (Jharkhand) and Sarwan Kumar Himachal Pradesh Krishi Vishwavidyalaya (CSKHPKV) Palampur (Himachal Pradesh)

Methodology:

Experiment CSKHPKV: The study was conducted at Palampur during 2004 on six adult healthy mongrel dogs of either sex weighing 15-20 kg divided into two equal groups. The first group (A) was kept as control, whereas the second group (B) served as test group. Prior to the start of experiment the animals were acclimatized in college kennels as per standard practice. The animals were dewormed with suspension albendazole (Albomar, Agrivet India Ltd) @ 10 mg/kg body weight orally and vaccinated prophylactically against rabies by injecting Rakhsharab (Indian-immunologicafs-) @ 1 ml/animal given subcutaneously. All the animals were maintained on standard and uniform diet during the entire course of study.

Creation of fracture: All the animals were prepared for aseptic surgery routinely. They were anaesthetized by xylazine and ketamine @ 2 and 10 mg/kg body weight respectively, given intramuscularly 15 min. after subcutaneous injection of atropine @ 0.045 mg/kg. The left ulnar bones of all the animals were subjected to diaphyseal fracture by osteotomy done with the help of giggly wire saw, chisel and hammer. After the creation of fractures, the surgical wounds were closed routinely.

Preparation of harjore paste or ointment: The harjore (*Cissus quadrangularis*) plant stems were collected and completely dried in oven. These were finely ground in a grinder to form powder. Then 20 g of this powder was used for one application per animal. Just before application the powder was mixed with sufficient quantity of liquid paraffin to form a paste.

Application technique: The paste thus prepared was applied on the skin around the fractured limb and covered with a layer of cotton bandage in the animals of group B. The fractured limbs were then stabilized suitably by means of a bi-valved plaster of paris full-limb cast and secured with adhesive tape and bandages. The harjore paste was reapplied at every 4 days interval till 20 days after operation. No medication was used or applied on the fractured limb of animals of group A. However, the fractured limbs were also supported by external cooptation as applied in group B.

Evaluation of fracture healing

Clinical observations: Clinical observations: All the animals were clinically examined regularly for the development and progress of inflammation and oedema at the fracture site. The extent of lameness, weight bearing capability and extent of pain were also recorded. Besides, the routine clinical parameters such as rectal temperature, respiration rate and heart rate were also recorded on days 0, 3, 7, 15, 30, 45 and 60 after operation. The extent of lameness was evaluated during standing and locomotion phase (Table 4.14)

Table 4.14. Sign and extent of Lameness

Sign	Extent of Lameness

Animal not bearing weight on affected limb	+++
Animal is occasionally touching the toes	++
Animal is frequently touching the toes	+
Animal is bearing full weight on affected limb	–

Haemato-biochemical studies: About 5 ml blood was collected from cephalic or recurrent tarsal vein of all the dogs in heparinized syringes on days 0, 3, 7, 15, 30,45 and 60 after operation. A part of it was used for estimation of the levels of haemoglobin, haematocrit, total erythrocyte count (TEC), total leucocyte count (TLC) and differential leucocyte count (DLC). Plasma was separated from the remaining blood samples and the alkaline phosphatase activity and concentration of calcium and phosphorus were estimated using semi-automatic chemistry analyser (RA-50, Bayer India Ltd).

Radiological examinations: Plain mediolateral radiographs of the fractured limb were taken at 0, 15, 30,45 and 60 days after operation in all the animals using standard radiographic exposure factors. These radiographs were studied for assessment of fracture-healing process.

Angiographic studies: Angiograms of the fractured limb were obtained on days 0, 15, 30, 45 and 60 after operation. Arteriography was carried out in all the animals under general anaesthesia, taking routine aseptic precautions. The brachial artery of the fractured limb was exteriorized and cannulated using 20 G intravenous canula. The contrast agent containing diatrizoate acid and meglumi (Contrastin 76%, Dabur India Ltd) was injected @ 20 ml/animal rapidly into the brachial artery. The mediolateral radiographs were taken immediately after injection, using standard radiographic exposure factors. The canula was removed and the brachial artery was sutured using 6-0 vicryl (Ethicon). The surgical wound was closed routinely. The arteriograms were evaluated and compared and the course, number, contour and calibre of the vessels supplying the fractured area were studied to assess the amount of blood supply at the site.

BAU: The experiment was conducted on 10 cattle of different age suffering from the fracture. In first group of 5 animals (T), the paste of *harjore* was applied, and in second group of 5 animals (T2), the plaster of paris was applied. The X-ray was taken before application of plaster, and blood and serum were collected for haematological and biochemical estimation. Heart rate, respiration rate, rectal temperature, feed intake, extent of lameness and body weightbearing capacity on different time intervals, i.e., 0,15,30,45 and 60 days, were studied for clinical evaluation. Blood samples were collected on days 0, 15, 30,45 and 60 and haemoglobin (Hb), packed cell volume (PCV), total erythrocyte count (TEC) and total leucocyte count (TLC) were estimated by cell-counter (Sysmex, Japan). Calcium (Ca), phosphorus (P) and serum alkaline phosphatase (SAP) were also estimated. In group I (T1), the X-ray of fractured bones was taken on day 0 and a layer of paste of *harjore* was applied on the fractured bone. The thick layer of paste over the part was also covered by cloth and it was tightly secured by a thin rope. After 5 days the layer of the paste was removed and the next layer was spread after 15 days. The layer of paste was not removed and left for 60 days. In group II (T2) the fractured bone was aligned and a layer of cotton was spread and plaster of paris (PoP) was applied and left for 60 days.

Conclusion: Results of the studies conducted at CSKHPKV suggest that application of *harjore* (*Cissus quadrangularis*) paste over fractured bone hastened the fracture-healing process. Similar observations were also made in cattle at BAU. However, the extent of cure of lameness was better in the animals treated with Plaster of Paris. The fracture of long bone such as femur and humerus are problematic and the animals generally die. In this study also one animal died in each of the two treatments.

References: Singh, 1986[5]; Srivastava, 1982; and Singh & Udupa, 1965

4.14. ITK: Determination of efficacy of pigeon wate in showing oestrus symptoms in heifers

Description of the ITK: To induce oestrus and for showing heat symptoms in heifers, pigeon waste, mixed with jaggery, is fed to heifers 2-3 times a day. The disease is cured up to 60%. Treatment cost per animal is Rs 10-15.

Location of use of the ITK: This is practiced by the farmers of many villages in Badaun and Bareilly districts of Uttar Pradesh.

Experimenters: Indian Veterinary Research Institute (IVRI); and Govind Ballabh Pant University of Agriculture and Technology (GBPUAT)

Methodology: The ITK was validated initially at IVRI, Izatnagar and was included for GBPUAT, Pantnagar for cross-sectoral revalidation.

Experiment IVRI: During 2002-2004 of study, clinical trial was conducted on 30 anoestrous heifers. Of these, 22 animals were given pigeon waste @ 100 g orally for 3 consecutive days and eight heifers received standard allopathic treatment consisting of hormonal injection and mineral mixture. The animals were observed for heat and conception status. The pigeon waste collected from different localities was processed for analysis of minerals using atomic absorption spectrophotometer (AAS).

GBPUAT: Pigeon waste was collected from the local areas of district Rampur. It was cleaned from debris (like sand, feathers and stone particles), dried and powdered. A dose of 100 g was prepared and packaged in polythene bags.

Mineral analysis of pigeon waste: Concentration of minerals (calcium, magnesium, iron, copper, cobalt, zinc and manganese) in the grinded pigeon waste was estimated using atomic absorption spectrophotometer.

Effect of pigeon waste on anoestrus animals: Forty animals were selected for the study and divided in two groups having 20 animals each. Group 1 was given pigeon waste 100 g, orally for 3 days, however, group 2 animals were treated with Receptol, 5 ml, I/M as a single injection.

Effect of pigeon waste on reproductive organs of prepubertal female Swiss mice: Prepubertal female Swiss mice (n=50) were procured from IVRI, Izatnagar. The age of all the mice was 20 days. The reproductive cycles were also assessed by vaginal cytology, which confirmed the noncyclic stage of the mice. All the mice were randomly divided into 3 groups, each having 16 mice. Group 1 was given normal feed, group 2 was given normal feed plus pigeon waste in the ratio of 1: 0.5, and group 3 was given normal feed and pigeon waste in the ratio of 1:1. All feeds were given ad lib for 8 days.

Vaginal cytology was also observed for the diagnosis of the stage of oestrous cycle, if cycle started. Blood was collected directly from heart after administering anesthesia using anesthetic ether to all the mice and plasma was harvested for the estimation of estradiol and progesterone. Mice from all the groups were sacrificed, and their genital organs were collected and weighed to observe the difference in weights in relation to control group.

Conclusion: The findings of IVRI, Izatnagar (during 2002- 2004) and GBPUAT, Pantnagar (during 2004) were almost similar and pigeon waste was found useful in bringing to anoestrus heifers to normal cyclicity and conception. The conception rate using this ITK was similar to that of standard hormonal treatment. However, the cost of treatment using ITK was much cheaper than that of standard veterinary treatment. Its mineral composition is almost similar to the commercially available mineral supplements. Experimental studies have suggested that ITK has beneficial effect on the development of reproductive organs and attaining puberty age early in the mice.

Literature Cited

Das, P., Das, S. K., Arya, H. P. S., Singh, R.P. 'Ratan', Mishra, Anupam., Bujarbaruah, K. M., Subba Reddy, G., Verma, L.R., Geetha Rani, M., Gupta, H.S., Satapathy, C., & Kavia, Z. D. (2003a). Inventory of Indigenous Technical Knowledge in Agriculture. Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge Document 2. Indian Council of Agricultural Research, New Delhi, March. 2003

Das, P., Das, S. K., Arya, H. P. S., Subba Reddy, G. & Mishra, A. (2002). Inventory of Indigenous Technical Knowledge in Agriculture. Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge. Document.1. Indian Council of Agricultural Research, New Delhi, JUNE 2002

Das, P., Das, S. K., Mishra, A., Arya, H. P. S, Bujarbaruah, K. M., Singh, R.P. Ratan, Verma, L.R., Subba Reddy, G., Geetha Rani, M., Gupta, H.S., Kavia, Z. D. & Ray, D.P. (2003b). Inventory of Indigenous Technical Knowledge in Agriculture, Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge. Document 2 (Supplement 1). Indian Council of Agricultural Research New Delhi. July. 2003

Das, P., Das, S. K., Mishra, A., Arya, H. P., Singh, R.P., Subba Reddy. G., Verma, L.R., Geetha Rani, M., & Ray, D.P. (2004a). Inventory of Indigenous Technical Knowledge in Agriculture, Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge. Document 2 (Supplement 2). Indian Council of Agricultural Research New Delhi. Dec. 2004

Das, P., Das, S. K., Mishra, Anupam., Arya, H. P., Singh, R.P. 'Ratan', Verma, L. R., Subba Reddy, G., Geetha Rani, M., Gupta, H. S. & Ray, D. P., (2004b). Validation of Indigenous Technical Knowledge in Agriculture. Mission mode Project on Collection, Documentation and Validation of Indigenous Technical Knowledge. Document 3. Indian Council of Agricultural Research New Delhi. March. 2004.

Das, P., Das, S. K., Mishra, Anupam., Singh, R.P. 'Ratan', Subba Reddy. G, Arya, H. P. S., Geetha Rani, M., Verma, L.R. & Ray, D.P. (2004c). Cross-Sectoral Validation of Indigenous Technical Knowledge in Agriculture. Document 4. Indian Council of Agricultural Research, New Delhi. Dec. 2004

FAO (2017). *The future of Food and Agriculture– Trends and challenges.* ww.researchgate.net/publication /330149688_The_Future_Challenges_of_Fo

Fukuoka,1975 (in Japanese) and (in English) 1978). re-presentation *The One-Straw Revolution: An Introduction to Natural Farming).*

Kumar, Ranjit., Kumar, Sanjiv., Yashavanth, BS., Meena, PC., Indoria, AK., Kundu, S. & Manjunath, M. (2020). Adoption of Natural Farming and its Effect on Crop Yield and Farmers' Livelihood in India. ICAR-National Academy of Agricultural Research Management, Hyderabad, India.

National Centre for Organic and Natural Farming (NCONF). Natural Farming. Department of Agriculture and Farmers Welfare. https://ncof.dacnet.nic.in/ConceptNaturalFarming

NITI Aayog, (2021). Natural Farming, https://naturalfarming.niti.gov.in/benefits/

Sala, S. Farioli, F. & Zamagn, A. (2012). Progress in sustainability science: lessons learnt from current methodologies for sustainability assessment: Part 1. Int J Life Cycle Assess DOI 10.1007/s11367-012-0508-6. (Progress-in-sustainability-science-Lessons-learnt-from-current-methodologies-for-sustainability-assessment-Part-1.pdf (researchgate.net).

Singh, D.P. (1986). Studies on dynamics of bone healing by the administration of certain bone inducers in caprine. Ph.D. thesis, submitted to BAU, Ranchi;

Singh, R.H. and Udupa, K.N. (1965). The effect of calcium and ascorbic acid on healing of fractures in thyroxin treated animals. *Indian J. med. Res.*, 53 (3),232-239

Srivastava, R.M. (1982). Cattle in culture and economy of tribal mundas of Bihar. Ph.D. thesis, submitted Kurukshetra University, Kurukshetra (Haryana);

Wikipedia, the free encyclopaedia. Natural farming. https://en.wikipedia.org/wiki/Natural_farming.

Chapter: 5

System Diversification in Natural Farming

Introduction

Diversification is widely held to offer significant scope for improving the economic viability of many farm businesses and, in turn reducing their necessity to produce primary subsidised agricultural supplies. A resilient food system must be financially reasonable (economic resilience), supportive of the entire public (social resilience), and must minimize injurious impacts on the natural environment (ecological resilience). Diversification of production should incorporate different levels of the organisation (Fig 1).

Agroecology, an approach receiving increasing devotion in research and agricultural practice, attempts to explicitly influence the benefits of agroecological relationships and diversification at the field, farm, landscape and regional scales and up to the broader food system. However, while diversification of crops and cropping systems has regularly been investigated, diversification of agricultural landscapes and regions also justifies consideration as it has many beneficial effects on biodiversity and ecosystem facilities. The tangible solutions for diversification of production will depend on the local and regional natural environment (*e.g.* soils, climate and geography) and the socio-economic and cultural conditions influential to present farming systems.

Understanding diversified farming systems is an ecological–economic trade-off for successful diversification strategies. Positive outcomes of crop diversity for agricultural employment worldwide have been described, but diversifying farming systems' economic costs often compensate for the ecological benefits. There is a need for acceptable policies to support the development of diverse and sustainable (ecological, economic and social) production, farming systems, and households. System diversification in agriculture refers