Technical Bulletin No.30

CELEBRATING 25 Years Silver Jubilee Publication

Agricultural Technology Options

ICAR Research Complex for Goa

(Indian Council of Agricultural Research)

Old Goa - 403 402, Goa, India

Technical Bulletin No.30

CELEBRATING 25 Years Silver Jubilee Publication

AGRICULTURAL TECHNOLOGY OPTIONS

Edited
by
B. L. Manjunath
B. K. Swain
Mathala J. Gupta
R. Maruthadurai

भाकृअनुप
ICAR
ICAR Research Complex for Goa
(Indian Council of Agricultural Research)
Old Goa - 403 402, Goa, India.

Published by
Dr. N. P. Singh
Director
ICAR Research Complex for Goa
Old Goa - 403 402, Goa. India

Fax : 91-832-2285649
Phone : 91-832-2284678, 2284679
Email : director@icargoa.res.in
Website : http://www.icargoa.res.in

Correct Citation:
B. L. Manjunath, B. K. Swain, Mathala J. Gupta, R. Maruthadurai. Agricultural Technology Options. Technical Bulletin No. 30, ICAR Research Complex for Goa (Indian Council of Agricultural Research), Old Goa-403 402, Goa, India.

Technical Assistance: S. K. Marathe

Printed at: **Impressions**, *Belgaum*

डॉ. नरेंद्र प्रताप सिंह
निदेशक

Dr. Narendra Pratap Singh
Director

गोवा के लिए भा. कृ. अनु . प . का अनुसंधान परिसर
(भारतीय कृषि अनुसंधान परिषद)
ICAR Research Complex for Goa
(Indian Council of Agricultural Research)
Old Goa - 403 402
Tel.: 0832-2284677/678/679
Fax: 0832-2285649
Email: director@icargoa.res.in

Preface

India has achieved a record food production of 257.44 MT in 2011-12 crop year but still there is a need for ushering in a second broad-based, sustainable green revolution to meet the mounting future domestic food grain demands.

ICAR Research complex for Goa was established as an independent Institute under the ICAR since 1989 and has been conducting strategic and applied research for Goa region. The Institute is blessed with a small but competent multi-disciplinary group of scientists involved in inter-disciplinary research to develop suitable technologies for the state and region. The Institute is planning for the twelfth plan proposal and as a consolidation of all its research efforts in the past years an inventory of all the successful technologies developed by the scientists of the Institute is being published. The enlisted technologies have been tested in Goa and found suitable for recommendation, for the entire Western region of India.

This publication has been drafted to aid a wide spectra of beneficiaries *viz*,. farmers, policy makers, state government officers of various line departments to ensure a ready reference of suitable technologies and is focused on promoting awareness, dissemination and adoption of these technologies to achieve sustainable agricultural growth in the state and region. This ready reference is designed to provide state governments and policy makers with additional information on the available technologies in agriculture, horticulture, fisheries and animal science to aid them with latest know–how to promote them in the region. I am confident that the technology option publication will contribute to trigger initiatives that could potentially lead to significant improvements in agriculture, horticulture, fisheries and animal science sectors in the region.

(Narendra Pratap Singh)

डॉ. अलोक कुमार सिक्का
उप महानिदेशक (प्रा . सं . प्र)

Dr. Alok K. Sikka
Deputy Director General (NRM)

भारत सरकार
कृषि अनुसंधान और शिक्षा विभाग एवं
भारतीय कृषि अनुसंधान परिषद
कृषि मंत्रालय, कृषि भवन -II पूसा , नई दिल्ली 110112

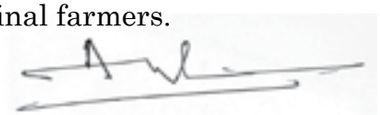
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
KRISHI ANUSANDHAN BHAVAN-11, PUSA, NEW DELHI 110 112
Ph. : 91-11-25848364 (O), 24121571 (R)
Fax: 91-11-25848366
E-mail: aksikka@icar.org.in., aloksikka@yahoo.co.in

Foreword

The West coast region of India has unique agro-climatic conditions with varying slopes, soils and cropping pattern. The region is not only suitable for field and horticultural crops but also for rearing of livestock and fisheries. ICAR Research Complex for Goa, the principal research facility of ICAR in the region, since its inception has evolved several agricultural technologies suitable for the region. These include resource conservation strategies, system approach for different production systems, identification of high yielding varieties, production and protection technologies in different field and horticultural crops including post-harvest management. Technologies under animal sciences include identification of profitable breeds of livestock, and nutritional and other management including disease management. Integrated fish based systems, mussel farming, ornamental fish culture and weather-based advisories are some of the technologies developed under the fisheries sector.

I am happy to note that the ICAR Research Complex for Goa has made efforts to bring out this comprehensive Research bulletin entitled "AGRICULTURAL TECHNOLOGY OPTIONS" showcasing the research carried out by the Institute. The untiring efforts of scientists involved in developing technologies for the region is duly acknowledged.

This compilation will help in evolving location-specific production packages and for formulating future research strategies as well as to provide relevant information to the researchers, extension workers as well as the farming community. I am sure that this bulletin will serve as a reference material to all those who are involved in enhancing the production and profitability of agricultural systems in the region and will go a long way in improving the livelihood security of small and marginal farmers.



(Alok K Sikka)

Contents

Animal Sciences

Fishery Science

Introduction

Goa and its adjoining areas lie in the West Coast region which falls in the twelfth agro climatic region of India. The State forms a part of the Konkan tract and is bound by Arabian Sea on the West and the states of Karnataka and Maharashtra on the other three sides. It has a warm humid and equanimous coastal climate which is ideally suited for all kinds of agricultural activities viz; cultivation of annual, perennial and horticultural crops, livestock enterprises and fish farming. Nearly 82 per cent of the land holdings are less than one hectare. Due to increasing labour costs, cultivation of field crops especially rice is becoming unprofitable. The farmers of the State are, therefore, increasingly taking up the horticultural crops with the emphasis on mixed farming wherein farming system research including watershed management is gaining importance. Goa also does not have Agricultural University or any other research organization to look after specific agricultural research needs of the State.

The Indian Council of Agricultural Research, New Delhi, therefore, established the ICAR Research Complex for Goa in April, 1976. After a short spell under the ICAR Research Complex for North East Region, the Complex was under the administrative and technical control of the Central Plantation Crops Research Institute, Kasaragod, Kerala. After functioning at different Government agricultural farms in Goa, it was finally shifted to its present location at Ela, Old Goa in 1982. In order to intensify further the transfer of technology and to impart grassroot level vocational training, a Krishi Vigyan Kendra was also established at the Research Complex in 1983.

Keeping in mind the ever growing needs of agricultural research, education and extension of the state of Goa, the ICAR, New Delhi, upgraded this Research Complex to a full fledged Institute in April, 1989. The Research Complex carries out applied and strategic research with some amount of basic research specific to this region, in field and horticultural crops, livestock and fisheries. In all, the Research Complex has 51.03 ha land. The Institute is headed by the Director. The staff strength of 93 comprises of 17 Scientists from different disciplines on research side and another 19 technical, 21 administrative and 32 supporting staff.

The research activities are carried out under five functional groups viz., Resource Management and Integrated production, Crop Improvement and Protection, Horticulture, Animal Sciences and Fisheries. Transfer of technology programmes are organized for farmers comprising both on campus and off campus training and field demonstrations through active participations of KVK.

The Institute is also a centre for AICRP on Cashew, Integrated Farming System (IFS) and Pig and Volountary Centre for AICRP on Rice, Arid Legumes and Vegetable Crops. Institute also has a Mega Project on seed production in agricultural crops and fisheries and also has externally funded projects on *Phytophthora*, *Fusarium* and *Ralstonia* diseases of horticultural and field crops, Indo German Consortium for epidemiology and comparative genomics of *Listeria* and Validation of Potential Fishing Zones (INCOIS).

Mandate and Objective

The Institute was started with a mission to achieve, "the introduction and improvement of all potential crops and various species / breeds of livestock and scientific exploitation of various aquatic resources, for improving agriculture production in Goa and the adjoining coastal region".

Mandate

1. To conduct basic, strategic and applied research on agricultural and horticultural crops, livestock and fisheries relevant to natural resource base of Western Coastal region for sustainable productivity
2. To collaborate with national and international institutes/agencies in developing and transferring new technologies for coastal areas
3. To act as repository of information on Western coastal agricultural system
4. To disseminate improved technologies developed and undertake training for skill and entrepreneurship
5. To act as centre for agro-eco tourism
6. To generate nucleus planting material
7. To provide consultancy services

Objective

Institute is having objective to take up applied and adoptive research, screening of varieties and standardization of technology packages suitable to local agro climatic situations. In specific areas of relevance, strategic and basic research aspects of national importance will be taken up for promotion of local and international markets.

Resource Management and Integrated Production

1. 1 Technology package for management of mine reject soils

Dr. H. M. Wasnik
Email: blmanjunathagri@gmail.com

Introduction

The land adjacent to Western Ghat and undulating forest belt is rich in minerals and ores and mining forms the second largest industry in Goa. It focuses on ores of iron, bauxite, manganese, clays, limestone and silica. The maximum area under mining is in Sanguem Taluka followed by Bicholim, Sattari and Quepem. The area under mining leases is about 30,000 ha (300 square kilometers). Mining is both by manual and mechanical employing open-cast method. The annual production of iron ore is around 15 million tonnes. The ore is mainly exported to Japan, European countries, China and South Korea through the Mormugao Harbour.

Mining is creating a damage to the environment mainly by the reject dumps, pumping out of muddy waters from the working pits including those where the mining operations have gone below the water table, and slimes from the beneficiation plant. The damage is more evidenced during monsoon when the rain water carries the washed out material from the waste dumps to the adjoining low-lying agricultural fields and water streams. The slimes and silts, which enter the agricultural field are of such character that they get hardened on drying. The washed out material from the dumps and the flow of slimes from the beneficial plants besides polluting the water causes siltation of water- ways. Such silting of water ways over the years may trigger even flooding of the adjacent fields and inhabited areas especially during monsoon.

Technology

The recommended practice is to construct contour bunds on the upper surface of the mine reject dumps with water ways for the safe disposal, peripheral triangular planting of silvicultural species, planting cashew with amendments like poultry manure @5kg/pit interspersed with planting of hardy and native grasses on plain as well as side slopes.

A view of the mining in the region

Cashew grown under poultry manure amendment

Estimation of cost

As the ownership of these lands rests with mine owners, legal restrictions need to be imposed to follow the rehabilitation guidelines strictly to safeguard the ecology of the region.

Cost of contour bunding with water ways/ha= ₹ 37,000 (with a life span of 10 years).

Cost of sylvicultural species at 2 x 2 spacing on borders= ₹ 6000.

Cost of high yielding cashew grafts at 8 x 8 m spacing= ₹ 20,000.

Cost of digging pits of size 2' x 2'for sylvi-cultural species and cashew= ₹ 4000.

Cost of planting native grass species on sloping sides and plain areas= ₹ 5000.

Cost of poultry manure @ 5kg/pit for cashew= ₹ 2000

Benefits envisaged

By following the package an improvement in soil and water retention of the mine dumps inturn avoiding siltation of adjacent rice field and water bodies would be of great ecological impact in the long run.

Additionally, cashew can give nuts 3-5 kg/plant from 5th year onwards alongwith apples @50 kg/tree which together could lead to return of ₹ 55000/ ha. Further sylvicultural species especially *Casuarina*, *Acacia mangium* and *Acacia auriculiformis* could yield timber every 5th year that can fetch return of 10000/ha. The forage grass could lead to a return of ₹ 5000/ha.

Additional income generation with the adoption of technology package

Technology	Investment (₹ //ha)	Production potential (t/ha)	Potential income generation (₹ / ha)
Contour bunding of dumped surface with water ways, planting of Sylvicultural species at 2 x 2 spacing on borders, high yielding cashew grafts at 8x8 m spacing with poultry manure @ 5kg/pit and planting native grass species on sloping sides and plain areas	₹ 36,700	Cashew nuts-1.0 Cashew apple-5.0 Wood-1000 m^3	₹ 70,000

1.2 Continuous / staggered contour trenches with vegetative barriers for soil and water conservation in cashew

Dr. S. Manivannan
Email: blmanjunathagri@gmail.com

Introduction

The Western Ghat and the adjacent coastal region of India receives high rainfall with higher intensity and erosivity coupled with steeper and longer lengths of slopes causing severe erosion and land degradation problems rendering the crop cultivation difficult without adopting proper soil and water conservation measures.

Cashew is the predominant crop in the sloping uplands of Goa covering an area of 55,732 ha. The crop is cultivated in area of 40,586 ha in North Goa district and in an area of 15,146 ha in South Goa district.

Technology

Bio-engineering measures viz. Continuous contour trenches/ staggered contour trenches with vegetative barrier of *Stylosanthes scabra* and *Vetivaria zizanoides* are suitable for reduction of soil loss and runoff with better growth and productivity of cashew.

A view of cashew growth under continuous contour trenches

Estimation of cost

Cost of continuous contour trenches with vegetative barrier of *Stylosanthes scabra* and *Vetivaria zizanoides* /ha: ₹ 36,000 (with a life span of 10 years). Cost of staggered contour trenches with vegetative barrier of *Stylosanthes scabra* and *Vetivaria zizanoides* /ha: ₹ 27,200 (with a life span of 10 years). Cost of high yielding cashew grafts at 8x8 m spacing including cost of cultivation of cashew: ₹ 20,000/ha. Cost of *Vetivaria zizanoides* root slips and their planting: ₹ 2000. The total cost involvement for the bio-engineering measures is around ₹ 49,000 to 58,000/ha.

Benefits envisaged

By following the technology there will be conservation of soil and water in the sloping areas/ fields which would be of great ecological impact in the long run. Additionally, cashew, can give 3 kg nuts/plant from 5th year onwards along with apples @ 25 kg /tree which together could lead to return of ₹ 40,000 /ha.

The economic analysis of the study indicated a benefit cost ratio of 6.82 to 6.87.

Additional income generation with the adoption of technology package

Technology	Investment (₹/ha)	Production potential	Potential income generation (₹/ha)
Continuous contour trenches/ staggered contour trenches with vegetative barrier of *Stylosanthes scabra* and *Vetivaria zizanoides*	25,600	Cashew nuts-0.6 t/ha Cashew apple-3.0 t/ha Stylo + Vetiver-10.0 t/ha	40,000
Staggered contour trenches with vegetative barrier of *Stylosanthes scabra* and *Vetivaria zizanoides*	24,700	Cashew nuts-0.6 t/ha Cashew apple-3.0 t/ha Stylo + Vetiver-10.0 t/ha	40,000

1.3 Direct water catch pits for off-season irrigation

Dr. S. Manivannan
Email: blmanjunathagri@gmail.com

Introduction

Although the West coast region receives heavy rainfall, the distribution is limited to only during South–West monsoon for a period of four months in a year. Thus, during the remaining part of the year the crop cultivation is seriously limited by availability of water/ moisture in the soil.

Water stored under direct water catch pits with silpaulin lining

Technology

Water harvesting and recycling will mitigate the problems of droughts and enhance the productivity of water in the region during the lean period. Small size direct rain catching ponds of size 2x2x1 m^3 (in deep soils) or 4x1x1 m^3 (in shallow soils) in the center of 8-10 plants of horticultural species with lining of 200 GSM silpaulin polyfilm.

Estimation of cost

Cost of high yielding cashew grafts at 8x8 m spacing including cost of cultivation of cashew is ₹ 20,000/ha. The total cost of the

pond of size 2x1x1 m^3 is ₹ 2900/ pit which can store 3.00 to 3.20 m^3 of rain water.

The total cost/ha for 20 pits =58000 with a life of about 5-6 years. The total cost of the pond of size 4x1x1 m^3 worked out to ₹ 2400/ pit which can store 3.0 to 3.20 m^3 of rain water. The total cost/ha for 20 pits is ₹48000 with a life of about 5-6 years.

Benefits envisaged

The technology was found to be practically feasible and economically viable means of providing off season irrigation during non rainy period.

The harvested water can be irrigated for 8-10 cashew or mango plants during summer months @ 10 litres/week/plant.

Additional income generation with the adoption of technology package

Technology	Investment (ha/year)	Production potential (t/ha)	Potential income generation (ha/year)
Ponds of size 2x1x2 m^3 (in deep soils)	₹ 14600	Cashew nuts-0.8 Cashew apple-3.0	₹ 39000
Ponds of size 4x1x1 m^3 (in shallow soils)	₹ 13600	Cashew nuts-0.6 Cashew apple-3.0	₹ 40000

1.4 Cashew based land use systems

Dr. S. Manivannan
Email: blmanjunathagri@gmail.com

Introduction

Cashew is the predominant crop in the sloping uplands of Goa covering an area of about 55,000 ha. The majority of the old plantations are of seedling progeny with varying production levels.

Cashew + Pineapple in Continuous Contour Trenches

Efforts are being made to replace the seedling with high yielding grafts of Goa-1 variety of cashew released by the Institute. Due to the canopy spread, the crop is spaced at a 8 x 8 m leaving a wide scope to have profitable cashew based intercrops so as to supplement the poor returns from the crop.

Technology

Growing Giant Kew variety of pine apple on contour trenches across the slope in cashew plantations was found more beneficial.

Estimation of cost

Cost of continuous contour trenches of size 0.45x0.90x0.45m^3 /ha - ₹ 51000 (with a life of 10 years). Cost of high yielding cashew grafts at 8x8 m spacing including cost of cultivation of cashew - ₹ 20,000. Cost of pine apple suckers and their planting - ₹ 13,000/ha

The total cost involvement for the technology - ₹ 29,430/ha/year.

Benefits envisaged

The technology was found to be practically feasible and economically viable to provide additional returns especially in the early stages of cashew development.

Additional income generation with the adoption of technology package

Technology	Investment (₹/ha/year)	Production potential (t/ha)	Potential income generation (₹/ha/year)
Growing Giant Kew variety of pine apple on contour trenches across the slope in cashew plantations	29,430	Cashew nuts-0.8 Cashew apple-3.0 Pine apple-2.0	55,000

1.5 Coconut based high density multi-species cropping systems

Dr. S P. Singh
Email: blmanjunathagri@gmail.com

Introduction

Coconut is the predominant plantation crop in the valleys and midlands of Goa. Although the crop is widely distributed including households, the productivity and returns from the crop are very low. As the crop is widely spaced owing to its morphological features, there is a wide scope for cultivation of high value intercrops with irrigation which also found to enhance the coconut returns.

Technology

Growing banana (Tissue cultured Grand Naine) in the line of coconut on all the four sides (two plants each side) and two trenches of pine apple (variety Giant Kew at the center) and trailing black pepper on the cleared stems of coconut (by planting in North East direction).

Estimation of cost

Cost of cultivation of coconut/ha - ₹ 24,000 Cost of banana suckers, pitting of size 2' x 2' and their planting / ha - ₹: 41,000. Cost of pine apple suckers in trenches of size 6' x 3'x 1 ½' and their planting /ha - ₹ 18300. Cost of pepper cuttings in pits of size 1' x 1'x 1' and their planting /ha ₹ 3640. Total cost of the intervention ₹ 86940/ha.

Coconut+Banana+Pine apple+Black pepper- the lakhibagh of Goa region

Benefits envisaged

The technology was found to be practically feasible and economically viable means of providing cushioning impact against the escalating cost of production with nearly constant market prices for the coconut.

Income generation with the adoption of technology package

Technology	Investment (₹/ha)	Production potential (t/ha)	Potential income generation (₹/ha)
Banana	41,000	11.8	94,400
Pine apple	18,300	2.70	21,600
Black pepper	3,640	0.35	7,000
Coconut	24,000	5280	36,960
Total system	86,940	11.8	1,59,960

1.6 Coconut based farming systems

Dr. B.L.Manjunath
Email: blmanjunathagri@gmail.com

Introduction

Coconut when mono-cropped will not fully utilize the natural resources including space, sunlight, moisture and nutrients owing to its morphological features requiring wider spacing. Further, to sustain the soil fertility on a holistic perspective, a farming system approach in coconut is suggested.

Technology

Intercropping of high yielding fodder in the inter spaces of coconut and integration with dairy and biogas unit, recycling of wastes to the coconut garden through biogas slurry and coconut waste composting. The technology was found to be a suitable intervention to enhance and sustain the returns from coconut garden.

Estimation of cost

Cost of high yielding forage grasses intercropping and coconut /ha: ₹23,000. Cost of integrated dairy unit with five milch cows /ha: ₹.87100. Cost of biogas unit of 3 m^3 capacity (Deenabhandhu model): ₹ 32000 (with 10 years economic lfe span). Cost of coconut composting :/ha: ₹ 2000. Total cost of the intervention : ₹ 1,13,270

Benefits envisaged

The technology was found to be practically feasible and economically viable means of providing cushioning impact against the escalating cost of production with nearly constant market prices for the coconut crop.

Intercropping high yielding forage grasses in coconut and integration with dairy-the secret of success

Potential income generation from cocunut based farming system

Technology	Investment (₹/ha)	Production potential	Potential income generation (₹/ha)
High yielding forage intercrops	9,000	111 t/ha	66,600
Coconut	14,000	8,350 Nos.	58,450
Integrated dairy (with five milch cows /ha)	87,100	9,470 litres	1,13,640
Biogas unit (4 m^3)	3,200		7,200
Total system	1,13,300		2,45,890

1.7 Improved local cowpea selection for higher productivity

Dr. B. L. Manjunath
Email: blmanjunathagri@gmail.com

Introduction

Cowpea is a traditional pulse crop of the region with high market demand. The local cowpea *(Alsando)* known for its bold size, cooking quality and unique taste is preferred over small seeded cowpea. However, the yield levels of the local cowpea are generally low. Systematic survey was undertaken in the major cowpea growing areas of Goa for six years during the period from 2000 to 2006.

The crop grown in different areas of the region were studied for the selected traits. In all, a total of 69 identified accessions were collected during the period and among them, the superior accession was idendified.

Technology

The pooled mean seed yield indicated that Goa Nadora is consistent in yield performance (1007 kg / ha). Use of local cowpea selection Goa Nadora will improve the productivity.

Local cowpea selection with cluster bearing habit

Estimation of cost

Cost of high yielding local cowpea selection/ha -30kg seeds @ 80/kg

Benefits envisaged

Being the preferred food crop and the potential for improvement of yield in the light of improved productivity and the large scope for small and marginal farm holdings especially during *rabi* in rice fallows under residual soil moisture situations, the research results have a far reaching practical significance to enhance pulse production in the region with competitive gains by capturing the existing market for the produce.

Potential benefits from the cultivation of local cowpea selection

Technology	Investment (₹ /ha)		Production potential (₹/ha)		Potential income generation (₹ /ha)
	Without	With	Without	With	
High yielding local cowpea selection	1500	2400	4-5	8-10	40000

1.8 Rice based cropping/farming systems

Dr. B. L. Manjunath
Email: blmanjunathagri@gmail.com

Introduction

The traditional rice based cropping system followed in the region include rice-pulse (mostly local cowpea commonly called *Alsando*) and rice-groundnut under residual moisture situations and rice-vegetables under protective irrigation through surface dug out ponds. There is ample scope to improve both the productivity and profitability in the system by identifying suitable genotypes and through intensive management so as to enhance the returns for a rice grower and sustain the crop cultivation in the region.

Technology

Research trials conducted over five years have clearly proven the advantage of growing local brinjal under protective irrigation with a clear monetary advantage. Further, integration of allied enterprises of mushroom and poultry production can lead to substantial improvement in net returns.

Estimation of cost

Cost of brinjal production (local variety)- ₹ 9,270/ha. Additional cost for mushroom and poultry production: ₹.41,750/ha

Benefits envisaged

Rice, being the staple food crop and the potential for improvement of yield in the light of increasing cost of cultivation, small and marginal farm holdings, lack of organized commercial processing and marketing facilities in the region, the research results have a far reaching practical significance to instill confidence among the farming community to minimize the fallowing of lands and continue engaging in agricultural production.

Goa State being deficit in local vegetable production and importing from neighbouring states the technology will help to improve local vegetable production. Allied enterprises of mushroom and poultry have a better market in Goa, being a tourist place which can add substantial returns.

Integrated systems in enchaning the potential income from a unit land holding

Technology	Investment (₹/ha)		Production potential- rice grain equivalent yield (kg/ha)		Potential income generation (₹/ha)	
	Pre	Post	Pre	Post	Pre	Post
Rice (Karjat-3)– brinjal (local cultivar Agassaim)	15,230	24,500	4,311	11,122	34,615	87,640
Mushroom production as an integrated enterprise	--	11,650	--	4,305	--	25,650
Poultry production as an integrated enterprise	--	30,100	--	6,060	--	46,905

Local brinjal as a sequential crop after rice

Integrated mushroom production using paddy straw

1.9 Technology package for higher sugarcane production

Dr. B. L. Manjunath
Email: blmanjunathagri@gmail.com

Introduction

In Goa, sugarcane is presently grown over an area of approximately 912 ha. The annual production of cane in Goa is about 49,110 tonnes with an average productivity of 53-55 m.t/ha with a recovery of 8.5 per cent which is very low. Goa has a sugar factory with a crushing capacity of 1.75 to 2 lakh tonnes of cane annually. Thus the present availability of cane meets less than half of the requirement of the factory. This deficit is made by bringing cane from neighbouring states, which is not only uneconomical but also detrimental to the interest of local growers. Thus, there is tremendous scope to produce this cane locally by adopting improved technology package strategy. Further, there is a scope for bringing additional area under this cash crop especially in command areas of Salaulim and Anjunem irrigation projects.

Technology

The research results on the introduction and evaluation of suitable high yielding varieties of sugarcane for Goa situation indicated that Co-86032 is better both in terms of cane yield and sugar yield which needs to be popularised.

For the endemic areas of white wolly aphid incidence, SNK-61 was found more suitable. Planting the cane during February was found more optimum for realizing higher cane yield and sugar recovery.

Following the drip system of irrigation was found to be more economical with higher water use efficiency and returns per mm of water used.

A view of high yielding Co-86032 sugarcane variety

Estimation of cost

Cost of seed sets- ₹ 45,000/ha for improved variety. Cost of drip irrigation: ₹ 20,000/ha.

Benefits envisaged

By adoption of improved high yielding variety Co-86032 over the ruling variety Co-8021 the yield improvement is 41 t/ha which gives an additional income of ₹82,000/ha. Similarly, adoption of drip irrigation system over conventional furrow system gives additional yield of 8.87 t/ha with an additional income of ₹ 24,813/ha including an additional 41% of the area that can be irrigated through the savings of water.

Improved technology in influencing potential income generation

Technology	Investment (₹/ha)		Production potential (t/ha)		Potential income generation (₹/ha)	
	Existing	Improved	Existing	Improved	Existing	Improved
Adoption of improved high yielding variety Co- 86032 over ruling variety Co-8021	30,000	45,000	54	95	1,08,000	1,90,000
Adoption of drip irrigation	11,050	20,080	111.80	120.69	61,635	86,450

1.10 Productivity improvement in coastal saline soils

Dr. B. L. Manjunath and Dr. R.R.Verma
Email: blmanjunathagri@gmail.com

Introduction

Goa state being coastal, sea water ingression into the cultivated field making the soil saline is very common all along the coast. The

View of salt affected lands in Goa

salinity of these lands however varies in different seasons. During rainy season, the salinity of inundated water gets diluted with fresh water due to monsoons which however, further increases after the cessation of rainfall. The state has a sizeable area (18,000 ha) under this situation. As such prevention of sea water under ingression assumes significance.

As the ownership of these lands rests with tenant associations/ Communidades in several cases, the work needs to be executed on a community basis with the involvement of local Panchayats. Controlling the ingression of saline water through embankments and sluice gates will have long term implications in sustaining the productivity of soils for crop cultivation, pisci-culture, etc. Further, it will also regulate the seasonal employment activities of the associated people inturn influencing their socio-economic conditions.

Technology

The recommended practice is to

Traditional sluice gate for regulating the ingression of saline water

construct the embankments with a free board of 1 m above the high tide with a 3:1 slope on the sea/river side and 2:1 on the country side. The top width of the embankment ranges from 3 to 5 m depending on the site. The embankments have to be provided with one way sluice gates so that the ingress of the sea water into the land is prevented during the high tides and the inland excess water is drained out to the sea during the low tide. Further, it is suggested that the top of the embankments can be block topped and can be used as a road for transport so that the maintenance of the structures also will be taken care.

Further, an area of about 12,000 ha of this type can be used for salt tolerant rice varieties like CSR-27, CSR-10 (with average yield potential of 4.0 to 4.50 tonnes/ha) in place of usually broadcasted local varieties like *Korgut* (with average yield potential of 1.5 to 2.00 tonnes/ha). The amelioration of soil through incorporation of green manures like *Sesbania rostrata* / *Glyricidia maculata* along with the recommended doses of fertilizers for rice is more beneficial in these situations.

Salt tolerant rice CSR-27 with incorporation of Sesbania alongwith fertilizers

Estimation of cost

Each hectare of rice growing saline soils require 65 kg of rice. With quality rice seed costing @24/kg, the cost involved is 1560/ha. Further, for following the INM practices of green manuring and recommended fertilizers, an additional cost of ₹ 5,000 /ha is required. Thus, totally for the package the cost involvement /ha will be ₹ 6560/ha.

Benefits envisaged

By following the package an additional improvement of 2000 kg/ha yield is expected which can fetch an additional gross return of 14,000/ha.

The technology when practiced on 12000 ha of the salt affected lands of the State where paddy is cultivated could lead to a benefit of 1680 lakhs.

Additional income generation with the adoption of technology package

Technology	Investment (₹ / ha)	Production potential (t/ha)			Potential income generation (₹ / ha)		
		Pre	Post	Increase	Pre	Post	Increase
Growing of salt tolerant rice varieties	₹ 6560	2.0	4.0	2.0	₹ 20000	₹ 34000	₹ 14000

Crop Improvement and Protection

2.1 Rice varieties for rainfed shallow lowland and irrigated ecology

Dr. Manohara, K. K.
Email: manohar.gpb@gmail.com

Introduction

Rainfed shallow lowland ecology is the predominant rice ecosystem in Goa covering about 2/3 (28,000 ha) of rice area in the State. While, irrigated rice ecosystem covers approximately 15,000 ha during *rabi* season. Jaya (medium duration) and Jyoti (short duration) are the ruling rice varieties of the State and are of late becoming susceptible to various biotic and abiotic stresses because of which there is a reduction in the yield level. Medium duration rice varieties with grain type suiting to local mills are preferred by the farmers for cultivation under these ecologies.

Technology

Karjat-3

A variety from Regional Agricultural Research Station (RARS) Karjat, Maharashtra found suitable for this ecosystem. It is medium in duration (125 to 130 days), having medium bold grain type with yield potential of 6.0 – 6.5 t/ha. Suited both for raw rice and parboiling.

High yielding rice variety Karjat-3

High yielding rice variety Naveen

Naveen

A variety from Central Rice Research Institute (CRRI), Cuttack, suitable for cultivation both in *kharif* and *rabi* season.

It is a white kernelled medium bold grain type rice variety, matures in 120 to 125 days with yield potential of 6.0 to 6.5 t/ha during *kharif* and 6.5 – 7.0 during *rabi* season. Suited both for raw rice and parboiling.

Estimated Cost and benefits

- Cost of cultivation is Rs. 25,000/ ha including the cost of seeds, land preparation, fertilizers, sowing, weeding, plant protection and harvesting charges.
- Karjat-3: Yield: 6.0 – 6.5 t/ha (*kharif*).
- Naveen: Yield: 6.0 – 6.5 t/ha (*kharif*) & 6.5 – 7.0 t/ha (*rabi)*
- Gross income: ₹ 55,000 – 60,000/- per ha.

2.2 Salt tolerant rice varieties for coastal saline soils

Dr. Manohara, K. K.
Email: manohar.gpb@gmail.com

Introduction

Coastal saline soils cover about 18,000 ha of land in Goa of which 12,000 ha is being used for cultivation of rice during *kharif* season. Growing salt tolerant rice varieties is considered as the most economical and effective way of increasing crop production in salt affected soils compared to many means of management of saline soils which involves more cost.

Technology

Through evaluation of different salt tolerant rice varieties under coastal salinity situations in farmers' field, two varieties *viz*., CSR-27 and CSR-36, from Central Soil Salinity Research Insititute (CSSRI), Karnal were found suitable for cultivation under this situation. Salient features of these two varieties are given below.

Variety	Plant height	Duration	Grain type	Yield
CSR-27	115 cm	120 days	Medium slender	3.5 – 4.0 t/ha
CSR-36	110 cm	135 days	Medium slender	4.0– 4.5 t/ha

Likely cost and benefits

- Cost of cultivation is Rs. 20,000/ ha including the cost of seeds, land preparation, fertilizers, sowing, weeding, plant protection and harvesting charges.
- Yield advantage of about 1.5 – 2.0 t/ha over the existing local popular variety Korgut.
- Yield: 4.0 – 4.5 t/ha.
- Gross income: ₹ 45,000/- per ha.

Salt tolerant rice variety CSR-27

Salt tolerant rice variety CSR-36

2.3 Management of the red palm weevil using pheromone technology

Dr. J. R. Faleiro
Email: jrfaleiro@yahoo.co.in

Introduction

Coconut is a major plantation crop in Goa. Red palm weevil (RPW) is one of the most destructive pests of coconut in South and Southeast Asia. In India, about 12 per cent of young coconut palms falling in the susceptible age group of 5 to 20 years are attacked by RPW. Considering the value of the crop, the reported damage level is high, specially due to the fact that attack by RPW often results in the death of the palm. Being an internal tissue borer, RPW is difficult to detect in the palms in the early stage of attack. Repeated infestation of RPW is known to occur in and around heavily infested gardens, especially where severely infested palms are eradicated. This has been attributed to the highly aggregated spatial distribution pattern of the pest.

The existing management strategy for RPW mostly relies on the use of hazardous chemicals, both for the prophylactic and curative treatments.

Technology

Pheromone based trapping technology was standardized to minimize the infestation levels. Trap colour, trap surface, type of food bait, quantity of food bait, trap height, frequency of trap servicing, insecticide for the use in traps, attractiveness of food bait, longevity of pheromone lure and pheromone trapping density were standardized.

Method of trapping

Place one to two traps/ha with Ferrolure+ for trapping the RPW in the mass trapping programmes. Trap should be placed under tree shade at a height of one meter from ground level and needs to be serviced once in 10 days. Carbofuran 3G (0.05%) should be added inside the trap to kill the attracted weevils. Each lure will serve for six months.

Estimated cost of the technology

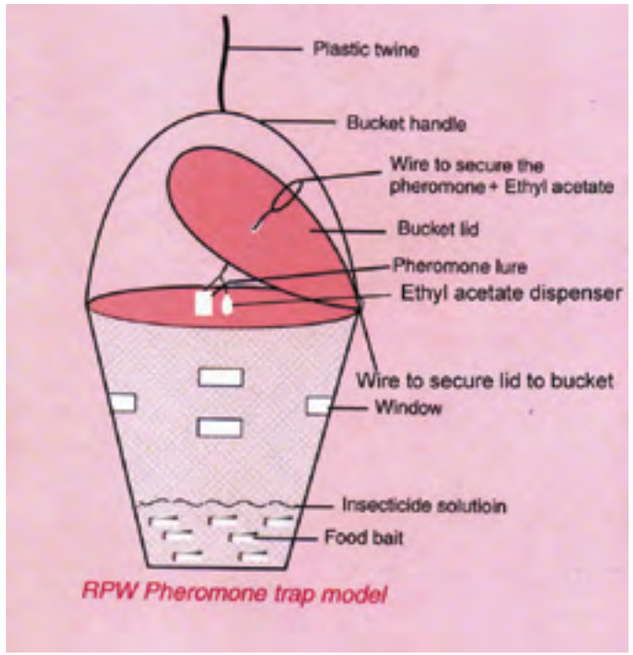
Cost of lure, pheromone trap and labour charges for servicing: Rs. 2000/ ha. All the materials are available in local shops and insecticide shops.

Benefits envisaged

Mass trapping reduced the incidence of RPW to less than one per cent compared to 10 per cent infestation in the un-trapped gardens thereby saving 15 trees per year.

Placement of trap

Red Palm Weevil adult



Trap Model

2.4 Management of the orchard fruit fly *bactrocera dorsalis using* methyl eugenol traps and hot water treatment

Dr. J. R. Faleiro
Email: jrfaleiro@yahoo.co.in

Introduction

Fruit flies are an important group of insects that occur across India. Studies on the abundance of fruit fly diversity in Goa revealed that among the orchard flies *Bactrocera dorsalis* is the most abundant species followed by *B. caryeae*, *B. zonata*, *B. affinis*, and *B. correct*a. In India, the loss in fruit yield ranges from 1 to 31% with a mean of 16%. The Orient fruit fly not only causes economic loss but is also of quarantine importance.

Symptoms of damage

- Maggot bore into semi-ripen fruits with decayed spots and dropping of fruits.
- Oozing of fluid
- Brownish rotten patches on fruits

Technology

Pheromone based trapping technology and hot water treatment was standardized to minimize the infestation levels.

Fabrication of Bottle Trap

Fabrication is by using disposable plastic water bottles (capacity: 1L). Each trap will have four windows of 1square inch, cut open just below the shoulder of the bottle. For facilitating the retaining of flies captured, the bottom of the bottle trap is cut and reversed into the open lower end of the bottle.

The trap is loaded separately with Methyl Eugenol (ME). ME blocks are prepared using plywood pieces of 5 X 5 X 1.2 cm which are soaked overnight in a mixture of ethanol solvent, ME and0.1 % malathion 50 EC in a ratio of 6:4:1 by volume.

Trap model for fruit fly

Each trap is fastened with the help of small nylon ropes to the twigs of the trees at 2m height. The lures need to be replaced at bimonthly intervals in order to sustain the trapping efficiency.

Hot water treatment of mango to control *Bactrocera* spp

Freshly harvested mangoes exposed to hot water at 48^0 C for 1 hr and 1.5 hrs, effectively controlled fruit fly infestation.

Infestation in the control treatment ranged from 3.33 to 30.00 per cent with either *B. dorsalis* or *B. caryeae* emerging from the infested fruits in the control treatment.

Hot water treated mangoes
(48^0Cfor 1 hr/48^0C for 1.5 hr/untreated control)

2.5 Management of the melon fly using food baits in hill cucurbits of Goa

Dr. J. R. Faleiro
Email: jrfaleiro@yahoo.co.in

Introduction

Hill cucurbits *viz*., cucurbits, ridge gourd, bitter gourd and snake gourd are cultivated by a specialized group of farmers in Goa called *mollekars*. These cucurbits are cultivated during *kharif* at the foot hills of Western ghats in the Goa region. A patch of 5 to 10 ha is cultivated together by a group of about 10 families who toil on the land collectively by sharing each others work while distinctly maintaining their identity on the piece of land cultivated by an individual family.

There are no reports on the area under these crops in Goa, however, the cultivation of these cucurbits has steadily increased in the state over the years and can be roughly estimated to be around 500 hactares of which cucumber occupies 50 per cent of the area followed by ridge gourd while (30%), bitter gourd (10%) and snake gourd (10 %). The melon fly, *Bactrocera cucurbitae* (Diptera: Tephritidae) is distributed widely through out the world damaging 81 host plants. B. cucurbitae attacks hill cucurbits of Goa with over 20 per cent infestation being recorded in cucumber. This pest can be successfully managed by application of food baits.

Data available with the ICAR, Old Goa suggests that damage due to B. cucurbitae in different cucurbits cultivated in Goa during kharif ranges from about 5 to 20 per cent with cucumber being most susceptible. Often farmers resort to use of harmful insecticides to control this pest which are mostly sourced through pesticide dealers resulting in several drawbacks including accumulation of pesticide residue in the fruit and damage to the fragile environment.

Technology

Prepare bait using banana (velchi) or jaggery make as 10 g banana / jaggery mashed up and liquidized in 1 L of water (10 % weight: volume). Add 2 ml malathion 50 EC to the above bait solution. Apply this bait by squirting (splashing) 8 L /ha @ 200 splashes / ha (each splash of approximately 40 ml) roughly equivalent to one splash every 7m

An overview of the Hill cucurbit

Placement of trap

in a square grid i. e. after every 10 steps in a square grid. Applications are to be made at weekly intervals, commencing from 30 days after planting up to the end of the commercial fruit production. In all, 8-10 application (squirting) of baits may be required per cropping season.

Estimated cost of the technology

Cost of the material and labour cost: ₹ 5000/ha

All the materials are available in local shops and insecticide shops.

Benefits envisaged

Benefit of ₹ 70000 per ha over a period of 3-4 months.

This ensures substantial (90 %) reduction in the insecticide load when compared to chemical control, while achieving control comparable with insecticide schedule i.e. < 5% damage. Bait application technique for melon fly management ensures insecticide residue-free crop, besides saving a substantial loss due to attack by *B. cucurbitae*. In the long run this can augur well for organic production of hill cucurbits to further enhance the profits.

2.6 Bio-inoculant based nutrient management and production of healthy and vigourous cashew grafts

Dr. R. Ramesh
Email: ramesh@icargoa.res.in

Introduction

Cashew is one of the important plantation crops of Goa, covering about 55,000 ha. The estimated production is about 27,000 tonnes. Most of the trees in Goa are from seedling progeny and are more than 25 years old. Yield from such plantations are very less as the farmers don't practice any nutrient management in these plantations. Of late farmers started planting grafts of improved varieties; the common varieties grown in Goa are Vengurla-4, Goa-1, and Vengurla-7, etc. Farmers use soft wood grafts of improved and high yielding varieties. Goa-1 variety is popular among the farmers next to Vengurla-4 with medium to bold nut size and excellent shelling percentage (30%). Its apple characteristics are best suited for *feni* making in the state. Majority of the farmers in the state don't follow any recommendations of fertilizer application and hence by default the crop is organic and the vigour of the trees and nut yields are low.

Bio-inoculants are useful microbes which help improve the growth of plants by various ways viz. fixing nitrogen, solubilise phosphorous, produce growth hormones etc. and another group of bio-inoculants suppress the growth of pathogenic microbes and help in better crop growth. Since majority of the cashew plantations are not applied with any fertilizers there is large scope for bio-inoculant based nutrient management in nursery as well as in new plantations.

Technology

Raising of bio-fortified grafts

Raising of cashew grafts in soil treated with bio-inoculants consortium in the nursery and planted in the field with the application of bio-inoculants consortium. The grafts produced on the bio-fortified nursery are superior to the grafts raised only using chemical fertilizer or no fertilizer treatment.

Method of bio-inoculant application in nursery

Bio-inoculants consortium needs to be mixed with organic manure or vermicompost and applied to the nursery bag. Then the seeds are sown in the bag. Once the seeds are germinated chemical fertilizers are applied after 20-30 days.

Bio-inoculant consortium/ plant: *Azospirillum* (10g) + P-solubilizer (10g) + *Pseudomonas* (10g) + Arbuscular Mycorrhizal Fungi-AMF (1g) (Population in all the bacterial formulations should be 10^8 CFU/g and in AMF it should be 250 spores/g)

Recommended dose of fertilizers (100%NP)/ plant: Urea (11g), Single Super Phosphate (25g)

Bio-inoculant based integrated nutrient application in the field

Once the grafts are ready for planting, next bio-inoculant treatment to be given during planting. Bio-inoculants consortium is mixed with organic manure or vermicompost and applied in the pit during planting. Once grafts are placed, cover the pit with top soil. Water the grafts if there is no moisture. After 15 days of planting apply fertilizers in the basin and cover with soil.

Bio-inoculant consortium/ plant: *Azospirillum* (25g) + P-solubilizer (25g) + *Pseudomonas* (25g) + AMF (10g) (Population in all the bacterial formulations should be 10^8 CFU/g and in AMF it should be 250 spores/g).

Organic manure: FYM (5kg)/ Vermicompost (1kg) per plant, Urea: 50g, Rock Phosphate: 75g and MOP: 20g to be applied during planting.

Estimated cost of the technology

No. of grafts/ha (6x6m): 277

Requirement of bio-inoculant (upto planting): *Azospirillum,* P-solubilizer and *Pseudomonas*- 10 kg each; AMF- 3 kg (Rs. 150 x 30 kg) + (Rs. 500 x 3 kg): Rs. 6000 per ha

Bio-inoculated consortium is prepared from the formulations obtained from the following research organizations.

Azospirillum and *Pseudomonas,* Kerala Agricultural University, Thrissur

Production of healthy, vigourous grafts; establishment of bio-fortified grafts in the field

P-solubilizer and AMF: The Energy and Resources Institute (TERI), New Delhi. Commercial formulation of AMF is available in Cosme Biotech Pvt. Ltd, Goa

Benefits envisaged

Production of healthy and vigourous cashew grafts and better establishment of grafts in the field

Saving of 25% to 50% of nitrogenous and phosphorus fertilizers (8-16 kg Urea, 12-24 kg Rock phosphate per ha during planting). During the next few years the savings in the chemical fertilizers is very significant quantity once the microbial inoculants based nutrient management is followed.

2.7 Technology option for mass multiplication and formulation of biocontrol agents

Dr. R. Ramesh
Email: ramesh@icargoa.res.in

Introduction

Biological control using Plant Growth Promoting Rhizobacteria **(**PGPR) as an alternate strategy gives immense scope in disease management and improved growth with the advantage of eco-friendly and sustainable technology. Rhizobacteria which exerts a beneficial effect on the plant being colonized are termed as Plant Growth Promoting Rhizobacteria. PGPR may benefit the host by causing plant growth promotion or by biological disease control. Many of the PGPR possess both of these effects on the plants. Soil borne plant diseases in Goa are very severe and are responsible for considerable yield loss in the important horticultural crops.

Majority of the above problems are

Production sequence of bio-control agents and the formulation

Formulation

Seed Treatment

soil borne in nature and the chemical pesticides are neither effective nor available in time. Indiscriminate and continuous use of pesticides in agriculture has resulted in several drawbacks *viz*. pesticide residues, resurgence of minor pests and emergence of resistance pathogenic races resulting the ineffectiveness of the pesticides. It is therefore appropriate to develop alternate strategies to manage diseases and to maintain vigourous growth of plants.

The loss caused by the soil borne diseases could be reduced considerably by adopting biocontrol without harming the environment. The bottleneck in this regard is the timely availability of quality biocontrol agent to the farming community.

Technology

Talc based formulation of biocontrol agent standardized for bacterial and fungal antagonists.

Viability as per standards: 4-6 months (minimum of 10^8 CFU g^{-1}) at 8-12% moisture condition.

Amendments were evaluated to enhance the shelf life of the formulation.

Estimated cost of the technology

Cost of setting up of a biocontrol production unit: Rs. 50.0 lakh (excluding land cost) for the production capacity of 10t/ year.

Benefits envisaged

Gross income from the sale: Rs. 15.0 lakh per year

2.8 Management of bacterial wilt in brinjal using bacterial biocontrol agents

Dr. R. Ramesh
Email: ramesh@icargoa.res.in

Introduction

Cultivation of vegetables in the West Coast region is carried out mainly during the *rabi* season, after harvest of paddy. Among the vegetables, brinjal finds an important place in the cultivation. Though high variability exists in brinjal, a local cultivar "Agassaim" is the preferred one in Goa because of high flesh, less seeds and bigger fruit size. The brinjal cultivation in Goa is mainly affected by bacterial wilt (BW) and is a major production constraint. The local preferred cultivar, Agassaim is highly susceptible to BW and the incidence ranges from 30-100 per cent during *rabi*.

This pathogen has a wide host range of more than 450 plant species which makes its management difficult. Other than chemical fumigants, there is no commercial pesticide available for the control of BW. Conventional management strategies like crop rotation, date of planting, other cultural methods and soil treatment are not very effective. Resistant cultivars are limited to locations, climate and to the strains of the pathogen. Only a few varieties show stable resistance but are not generally preferred by the growers. As there is no single effective control measure available for BW, integrating different methods is a must.

Technology

Biocontrol is an eco friendly approach towards the management of Bacterial Wilt. For the effective biocontrol, the survival of the antagonist in the carrier and its delivery to the rhizosphere are

Incidence of bacterial wilt in brinjal

of prime importance. Talc based formulations of endophytic and plant growth promoting rhizobacteria are applied in different forms for instant soil amendment, seed coating and soil drenching. Treatment of brinjal seeds while sowing in the nursery reduces the incidence of bacterial wilt.

Method of treatment

In the nursery treatment, 50g of the talc based formulation is added per m^2 of the area of the nursery before sowing the seeds.

Talc formulation of the biocontrol agent containing 10^7 CFU/ g was mixed with water to form suspension at a concentration of 50g/ L. After transplantation, about 50 ml of the suspension was added per plant. The same application to be repeated after 15-20 days of transplanting.

Estimated cost of the technology

Cost of biocontrol agent and labour: Rs. 18000 per ha

Biocontrol agent formulation is made in ICAR Research Complex for Goa and used for the experiments and demonstrations. The same may be produced and given based on the request.

Benefits envisaged

Benefit (average 30% yield increase over the untreated field): 7.5 t fruit yield increase

i.e. Rs. 75000.00

Net additional income: Rs. 57000

BC ratio= 4.17:1

Further, the soil health is preserved over a period of time and chances of developing resistant pathogen strain is less.

Establishment of brinjal crop in the control

Bio-control agent treated plots

2.9 Seed treatment with biocontrol agent-a simple technology for the management of groundnut root rot under residual soil moisture conditions

Dr. R. Ramesh
Email: ramesh@icargoa.res.in

Introduction

Groundnut is a major oilseed crop in India accounting to 39 per cent of the total oilseed production and is grown in *kharif*, *rabi* and summer seasons. Larger area under groundnut in Goa is during *rabi* and mostly grown under residual soil moisture conditions after the harvest of paddy crop. A variety of diseases affect groundnut, majority of which are caused by fungi and lead to severe yield loss. Root rot caused by *Macrophomina phaseolina* is a major problem in Goa under dry conditions. This fungal pathogen is soil and seed borne; and causes root rot in more than 500 plant species posing serious problem in management. It has been reported that colonization of the roots and charcoal rot development occur only when the plants are drought stressed during reproductive growth. Incidence is ranged from 10 to 40 per cent leading to considerable yield loss. Infected plants produce unfilled or partially filled pods there by making the produce unfit for consumption or seed.

Technology

Seed treatment with fungicides is the recommended practice and has disadvantages like reduced efficiency due to change in the pathogen population, soil pollution etc.

Biocontrol is an eco-friendly approach towards the management of *M. phaseolina*. For the effective biocontrol, the survival of the antagonist in the carrier and its delivery to the rhizosphere are of prime importance. Talc based formulations of endophytic and plant growth promoting rhizobacteria are applied in different forms for instance, soil amendment, and seed coating.

Treatment of groundnut seeds with talc formulation of biocontrol agents before sowing reduces the incidence of root rot. With seed treatment, yield increases a minimum of 40 per cent over the untreated field.



Incidence of groundnut root rot in the field and yield loss in the affected plant

Method of treatment

Talc formulation of the bio-agent containing 3 x 10^8 CFU g^{-1} need to be mixed with water in such way to form slurry/ paste. Quantity of bio-formulation used is @ 30g per kg of seeds. Seeds of groundnut are mixed thoroughly in the slurry to form a thin coating over the outer layer. The treated seeds are kept in a container or bag under shade for a maximum period of 16 hours before sowing. The shade dried seeds to be sown in the furrows.

Estimated cost of the technology

Cost of biocontrol agent and labour: Rs. 500 per ha

Biocontrol agent formulation is made in ICAR Research Complex for Goa and used for the experiments and demonstrations. The same may be produced and given based on the request.

Benefits envisaged

Benefit (average 40% yield increase over the untreated field): 1.0 t pod yield increase
i.e. Rs. 3000.00
Net additional income: Rs. 2500
BC ratio= 6:1
Further, the soil health is preserved over a period of time and chances of developing fungicide resistant pathogen strain is less.



Bio-control treated seeds in a plastic bag and the establishment of crop in treated field

2.10 Management of seedling and graft rot in mango nurseries with biocontrol agents

Dr. R. Ramesh
Email: ramesh@icargoa.res.in

Introduction

Mango is the major fruit crop of Goa, covering 4000ha with an average production of 10t/ha. In mango, lot of variability exists in Goa. Since only a few systematically planted orchards are present in the State and keeping in view the huge demand among consumers, efforts are being made to popularize mango cultivation on commercial orchard scale. Among the mango varieties, Alphonso, Benishan and Kesar are considered the best mango varieties in India. Commonly exported, Alphonso is grown primarily in the Konkan region of Maharashtra. In Goa, the local cultivar *viz.* Mankurad is the most important popular variety. In addition to this, Hilario (also called as Mangilar), Malgeush, Mussarat are also commonly grown and preferred.




Wilting of seedling root stock, the rotten seed and the wilting of grafts

Mango seedlings are severely affected due to root rot caused by fungal pathogens as recorded during the last 3-4 years in several nurseries in the State. Both the root stocks and the grafts are damaged resulting in death of seedlings and grafts.

Due to infection, the stones fail to germinate if infected in the early stage or the germinated seedlings wilt. Severe mortality was observed in one month old mango grafts of Amrapali and Mankurad. The mortality of grafts is upto 30% and all the varieties are susceptible. Total mortality was observed in some of the nurseries.

Identified the cause of wilting and rotting in the seedlings and grafts. *Macrophomina phaseolina* and *Rhizoctonia solani* are constantly associated with the death of grafts. Recommended the use of biocontrol agents like *Trichoderma* spp. *Pseudomonas fluorescens* or *Bacillus* spp.

Technology

Treat the soil with talc based formulation of *Trichoderma* spp. @ of 50g/50kg of soil before placing the nuts. Apply talc based formulation of *Pseudomonas fluorescens* or *Bacillus* spp @ 10g/ graftduring planting.

After grafting apply 5g of talc based formulation of *Trichoderma* spp per graft. If the disease is noticed in the grafts, apply 2.5g of talc based formulation of *Trichoderma* spp or *P. fluorescens* or *Bacillus* spp per plant by pouring the solution prepared using water. In case of severe infection the above treatment may be repeated after 20 to 25 days.

Severely infected nursery

Establishment in the biocontrol treated nursery

Estimated cost of the technology

Cost of biocontrol agent and labour: Rs. 2500 per 1000 grafts

Biocontrol agent formulation is made in ICAR Research Complex for Goa and used for the experiments and demonstrations. The same may be produced and given based on the request.

Benefits envisaged

Benefit (average 40% more survival percentage than untreated nursery): 400 extra grafts in the treated nursery
i.e. Rs. 16000.00
Net additional income: Rs. 13500
BC ratio= 6.4:1

Horticulture

3.1 Goa-1: A new cashew variety for Goa

Dr. A.R. Desai
Email: adavirao@yahoo.com

Introduction

Out of 55,000 hectares of area under cashew plantations in Goa, major plantations comprising of heterogeneous, non-descript local seedlings account for almost 40000 hectares, thereby leading to low productivity (500kg/ha) and poor income from cashew crop in the state, while only 15000 hectares are covered under grafts of improved varieties like Vengurla-4 and Vengurla-7 wherein the productivity is observed to vary from 600 to 1800kg/ha. Therefore, there is need for multiple high yielding region specific varieties for enhancing production and productivity.

Technology

'Goa-1' is a selection derived by clonal evaluation of a local accession 'Balli-2', based on superior performance of a promising tree located in village Balli of Quepem Taluka in South Goa. Medium to bold nut size (7.41 - 7.92 g) and excellent kernel recovery (29.82 -30.05 %) of export grade (W210 -W240) coupled with higher nut yield are the important features of this variety. The high yielding feature of this selection is attributed to higher number of flowering laterals per sq.m. of canopy (15.93), male to bisexual sex ratio of 10.02 : 1 and bunch bearing habit (5–10 fruits per panicle), whereas the single largest panicle recorded as high as 26 number of nuts per panicle. This is a mid-season variety, with semi-spreading canopy due to which it is less affected by tea mosquito bug which is another desired feature of this selection. Yellow coloured bigger apples (about 70 g) with higher juice contents (66-70 %) of 12 ^{o} Brix are suitable for processing juice and distinctly advantageous for Feni industry.

Performance

This variety, on an average, yields about 9-10 kg/tree of raw nuts at the age of ten years. At regular spacing of 7m x 7m (200 trees/ha), about 1.8 tonnes of raw nut yield can be expected from one hectare besides the cashew apple yield of about 12–14 tonnes.

Inputs requirement and Rs/ha (for ten years)			Yield advantage (kg/ha)	Other benefits	Additional income Rs. /ha	Remarks on implementation
Material	Labour	Others				
1,50,300	56,380	13,800	1,000	Apple yield 12 tonnes per ha. and Employment generation	60,000	Technology is transferred through Directorate of Agriculture by providing nucleus planting material and also through Institutes FLDs.

Bunch bearing of Goa-1 cashew

Kernels of W210-W240 grade

Unit costs and returns (At first tenth year)

Gross Returns: Rs. 3,62,600 ; Total cost for 10 years = Rs. 2,20,530

Net Returns: Rs. 1,59,270 at 10th year

Net Returns/tree at 10th year = Rs. 417/tree

Suitable Areas: North Goa and South Goa districts

3.2 Technology for commercial production of ginger

Dr. A R Desai and Dr. N P Singh

Introduction

Major ginger growing states are Kerala, Karnataka, Gujarat, Arunachal Pradesh, Assam, Orissa, Himachal Pradesh, West Bengal, Meghalaya and Sikkim. Out of the total production of ginger, about 30 per cent is converted into dry ginger, 50 per cent consumed as green ginger and the rest used as seed material. The estimated world import of ginger is around 300,000 tonnes per year, which indicates the vast scope for exporting Indian ginger. Though agroclimatic conditions are suitable, area under commercial production of this crop is very negligible in Goa.

Improved technology

Cultivation of this spice crop is picking up in Goa, only from the recent years since the production technology coupled with seed material of improved high yielding varieties are made available to the farmers in the state by ICAR institute. Ginger can be cultivated both under rainfed and irrigated conditions, right from sea level to an altitude of 1800 m, in open fields as pure crop or in mixed cropping situation as intercrop either in coconut garden or in cashew plantations in the gestation period.

Well drained sandy loam, red loam or lateritic loamy soil having abundant humus with pH of 5.4-6.5 and is suitable for commercial cultivation of ginger. Due to exhaustive nature of the crop, it is recommended that the same field should not be used for growing ginger year after year and crop rotation may be followed preferably with suitable legumes depending on the situation.

Varieties

Different varieties of ginger are cultivated in different ginger growing regions. Varieties like Varada, and Himachal have been evaluated by

Variety	Fresh Mean yield (t/ha)	Maturity (days)	Dry recovery (%)	Crude fibre (%)	Oleoresin (%)
Varada	20.6	215	20.7	4.5	6.7
Himachal	18.5	215	22.1	3.8	5.3

ICAR Research Complex for Goa and found suitable for commercial cultivation under Goa conditions. The characteristic features of these varieties are presented below.

Production practices

Plough and harrow the land to pulverize the soil to a fine and friable tilth. Apply 1/3rd quantity (about 10 tonnes/ha) of well decomposed farm yard manure (FYM) at the time of ploughing to mix it well with soil. 'Broad bed and furrow' or 'ridge and furrow' method may be followed for growing ginger. In case of first method, raised beds of 15cm height and 1 m width of convenient length have to be prepared with 50 cm inter space between beds. In case of ridge-furrow method, furrows are opened 40-45 cm apart. Early land preparation in summer months helps to reduce the disease and nematode incidence due to solarization effect.

Planting Method

Just after receiving the premonsoon showers in the mid of May, is considered as the ideal time for planting. At the time of planting, soil should not be completely dry and also there should not be excess moisture. Planting can be taken up still early during March under irrigated conditions to derive the benefit of early harvesting. Early planting reduces the incidence of rhizome rot disease also.

Use healthy and bold seed rhizomes for planting.

Collect the seed material from disease free plots. About 1200-1500 kg/ha of seed rhizomes are required for planting depending on the quantity of rhizome used per spot, spacing followed and method of planting. Cut the rhizome clumps stored for seed purpose into small pieces of 20 -50 g with at least 1-2 buds in each piece. Based on the size of the seed rhizome bits, spacing and method of planting, the seed rate varies from region to region. If the bit size is about 20-25 g, about 1500-1800 kg/ha of seed rhizomes are required for planting at spacing of 25cm x 25cm in raised bed method. For ridge-furrow method, about 2500kg/ha of seed rhizomes are required for planting at a spacing of 25cm from plant to plant along the ridges opened at 40-45cm apart. Treat the Rhizome bits with mancozeb 0.3% (3 grams/L of water) for about half an hour by completely dipping in the solution followed by spreading in the shade for air drying for two hours before planting.

Seed bed preparation and fertilizer application

Apply the remaining 2/3rd quantity of well decomposed farm yard manure (20 tonnes/ha.) or compost @ 25-30 tonnes/ha either by broadcasting over the beds prior to planting or in the pits at the time of planting. Also incorporate *Trichoderma harzianum* at rate of 10 kg/ha., mixed with FYM into the raised beds or ridges. Application of neem cake @ 2 tonnes/ha at the time of planting helps in reducing the incidence of rhizome rot disease/ nematode and increasing the yield. The recommended dose of fertilizer for ginger is 100 kg N, 50 kg P_2O_5 and 50 kg K_2O per ha. The fertilizers are to be applied in split doses (Table 2). The entire dose of phosphorus has to be applied as basal dose along with manure before planting. In zinc deficient soils basal application of zinc fertilizer up to 6 kg zinc/ha (30 kg of zinc sulphate/ha) gives good yield.

Planting of seed rhizomes

Open the micro-pits on the raised beds at 25cm x 25 cm spacing in case of raised method or 20cm between plant to plant on the ridges in case of ridge and furrow method. Then, plant a piece of treated seed rhizome in the each pit and cover with thin layer of soil. After planting, mulch with green leaves to prevent dehydration of rhizomes and also to overcome the splashing of soil leading to exposure of seed rhizomes due to rains.

After care

Weed the plot before giving the top doses of fertilizers. Give the first top dressing after 40-45 days and

Table 2. Fertilizer schedule for ginger (per ha)

Fertilizer	Basal application	First top dressing after 40-45 days	Second top dressing after 95-100 days
N	-	50 kg	50 kg
P_2O_5,	50 kg	-	-
K_2O	-	25 kg	25 kg
FYM/Compost	20 tonnes,	,	,
Trichoderma	10 kg		
Neem cake	2 tonnes		
Mulching	Mulch with green leaves after planting	Mulch with green leaves after earthing up	

second top dressing after 95-100 days of planting (Table 2). Weeding is the most essential operation to be done just before each time the top dressing is done. After that, proper earthing up and mulching with green leaves will prevent exposure of rhizomes and facilitate free development of rhizomes, suppress the weed intensity and further help in moisture conservation in subsequent period. Proper drainage channels are to be provided to facilitate flow of excess rain water to avoid any water stagnation situation. Give foliar spray of 15:15:15 water soluble N:P:K at the rate of 10g per litre of water after 150 days to improve the development of rhizomes in case of rainfed crop under Goa condition.

Disease management:

Ginger crop is affected by rhizome rot or soft rot disease caused by the fungal pathogen *Pythium aphanidermatum*. Initial symptoms start with yellowing of leaves upon rotting of pseudo stem in the collar regions. The pseudo stem comes out easily upon pulling with rotten collar end.

Selection of seed material from disease free fields, Selection of fields having good drainage, application of *Trichoderma harzinianum* (10kg/ ha.) along with neem cake and planting of seed rhizome bits treated with mancozeb 0.3% (3 g/l of water) as described earlier will reduce the incidence of this disease. If the initial symptoms of the disease are noticed in the field, drench the affected plants and surrounding plants with copper oxy chloride solution (3g/l) to check further spread of disease to the other plants. Repeat the drenching if required at an interval of 20-25 days.

Another disease showing almost similar symptoms to that of soft rot is bacterial wilt caused by *Ralstonia solanacearum* Biovar-3. This is also a soil and seed borne disease. Water soaked spots at the collar region of the pseudo stem, mild drooping and curling of leaf margins of the lower leaves, yellowing from the lowermost leaves gradually progressing to the upper leaves are the initial symptoms.

The affected pseudo stem and rhizome when pressed gently extrudes milky ooze from the vascular strands. The cultural practices adopted for managing soft rot, selection of disease free seed rhizomes, treating seed rhizomes with Streptocycline 200 ppm for 30 minutes followed by shade drying before planting and . drenching with Bordeaux mixture 1 per cent or copper oxychloride 0.2 per cent help in the managing this disease.

Harvesting and handling

Harvesting can be done right from sixth month after planting depending on the purpose for which it is used. In general, the matured ginger rhizomes will be ready for harvesting in about eight – nine months after planting. At this stage, foliage starts drying gradually. Such rhizomes harvested after maturity, can be stored for seed rhizomes or for preparing dry ginger. Rhizome clumps are harvested by digging manually or mechanical harvesters. The dried foliage and root debris is removed from the rhizome clump and rhizomes are cleaned to remove the soil adhered to them. For fresh consumption, tender rhizomes with little or no fibre are harvested after sixth month onwards.

About 15 – 28 tonnes of fresh rhizome yield depending on the varieties can be harvested from one hectare area in about 8-9 months period.

Unit Cost of production : Total production cost will be about Rs.1.25 lakh, major cost being of the seed rhizomes. A net return of about Rs. 1.5-2 lakhs per ha. can be expected.

3.3 Cardozo Mankurad (Ingr11023): A Promising mango variety

Dr. A. R. Desai, Dr. N.P Singh and Dr. P. A. Mathew

Among several mango varieties of Goa, "Mankurad" is the most popular variety in the state. Due to continuous stone-propagation of Mankurad variety for several decades, there exists tremendous variability having desired traits within the population of this variety. Cardozo Mankurad is one such chance seedling selected for several superior characters over the parental variety. This promising selection was located in a homestead garden of Cardoso family in Mapusa city of Bardez Taluka in North Goa and selected for its regular bearing tendency, attractively coloured fruits with higher contents of fibreless pulp and better storage quality. Clonal progeny was developed from the mother tree and evaluated at ICAR Research Complex for Goa, for validating the desired traits. Progeny orchard of this new selection is being developed at ICAR Research Complex for Goa, Old Goa. Morpho-agronomic Characteristics of the new selection are presented in the table.

The soft wood grafting is a suitable propagation method for multiplication of grafts of this promising selection. One to one and half-year old grafts can be used for planting in the main field. Pits of one cubic metre size spaced at 8m x 8m or 10m x 10m distance are to be filled with top soil mixed with 15kg FYM, 1.0kg mussorie phosphate and 1.0 kg neem cake well before planting and kept ready for planting with onset of monsoon.

After one year, first year fertilizer

S. No.	Trait Description	Mankurad (Parent)	Cardozo Mankurad (Selection)
1.	Bearing	Alternate to irregular	Regular
2.	Yield	Medium	Heavy
3.	Fruit Size	Small to medium (278.0g)	Medium to large (320.0 g)
4.	Fruit Skin Colour	Yellowish orange with pink blush, seen mostly on ventral shoulder	Yellowish orange with Deep pink seen on both shoulders or throughout.
5.	Fruit pulp		
a	Texture	Melting	Firm, Melting
b	Aroma	Strong Aromatic	Aromatic (Rose)
c	Colour	Yellowish orange	Deep Orange
d	Fibre	Scanty	None
e	Flesh	75.98 %	78.29 %
f	TSS	21.0 ° Brix	22.0 – 25.0 ° Brix
6	Quality	Excellent	Excellent
7	Shelf life	Poor (3days)	Better (About one week)
8	Stone weight	28.5 g	22.67 g

dose of 150:50:50g of N, P_2O_5 and K_2O along with 10kg per graft of FYM has to be applied to each young graft. Doubled quantity of nutrients should be applied for two year old grafts and from third year onwards, the first year dose be added to the previous year's dose till 9th year. For ten year old trees, nutrients comprising of 1500 g N, 500g P_2O_5 and 500g of K_2O along with 50kg per tree of FYM need to be applied for better performance. Full dose of recommended nutrients has to be given in circular rings, 0.5-2.0m away from the trunk, in the month of August for rainfed gardens and incorporated into soil.

The trees of Cardozo Mankurad commence flowering during November-December and fruits become ready for harvesting during March-April. About 1500-2000 fruits may be harvested from each tree at tenth year and onwards. The grafts of this new selection are in great demand in the state, especially for taking up new commercial plantations.

3.4 Commercial production technology of turmeric under agro-climatic conditions of Goa.

Dr. A R Desai and Dr. N P Singh

Introduction

Commercial Cultivation of turmeric is either very rare or not in practice in Goa. There is lack of awareness about improved high yielding varieties of turmeric and also about improved / scientific production practices. Farmers, generally, do not adopt commercial cultivation of turmeric varieties as inter crops either in cashew plantations during the initial pre-bearing period or in coconut plantations in the state.

Improved Technology

Improved varieties of turmeric (like Prabha, Pratibha, Meghalaya selection-1, and Sudarshan) are found promising under agro-climatic conditions of Goa for commercial production both as inter crops in cashew and coconut plantations and also as pure crop in open fields.

Seed rhizome

About 25 quintals of turmeric seed rhizomes are required per hectare ar ea.

Ridge and Furrow method

Ridges and furrows are to be prepared 45 cm apart with help of adjustable ridger mounted on tractor, so that height of ridge is about 25 to 30 cm. Seed rhizomes are planted on one side of the ridge at the bottom at a spacing of 20 cm by opening the cup-pits. This method is suitable for high rainfall areas to overcome rhizome rot problem, especially when cultivated as inter-crop in coconut gardens.

Flat bed method

Raised beds of 1 m width and convenient size of length varying from 2 to 10m are to be prepared. Seed rhizomes are to be dip-treated in solution containing 2g of Bavistin per litre of water to overcome rhizome rot problem in field. About 50 g seed rhizome per spot is planted 6-8 cm deep in the cup-pits in both ridge & furrow method and flat method. Solution of copper oxy-chloride (2.5-3g/ltre of water) is used for drenching, if rhizome rot disease is noticed in the field.

Manuring and fertilizers:

Farm Yard Manure or Compost: About 30 – 40 tonnes per hectare.

Fertilizers: 175: 50:125 kg/ha of NPK

N and K fertilizers are to be applied in four split doses before 120 days (at 30, 60, 90 & 120 days) after planting. Fertilizer has to be covered by earthing up after each application.

Performance

Crop will be ready for harvest in about 8-9 months after planting, when leaves start withering. Dig out rhizomes to harvest, with light irrigation 3 days prior if the soil is too dry. On an average 22-25 tonnes of fresh rhizome yield of turmeric can be expected from one hectare of planted area.

Unit costs and returns

Total production cost will be about Rs.1.25 lakh, major cost being of the seed rhizomes. One can expect a net returns of about Rs. 1.5-2 lakhs per ha.

Processing of Turmeric

Fingers are separated from mother rhizomes which are usually kept as seed materials. The fresh turmeric is cured for obtaining dry turmeric for marketing. The rhizomes are collected, cleaned and processed. Processing involves boiling of fresh rhizomes in water, drying and polishing.

1. **Boiling:** The improved boiler consists of 2 rectangular shaped perforated containers placed inside an outer metallic container provided with lid. The outer container is made of a

rectangular trough of size 1.2m x 0.9m x 0.9m with 3mm thick mild steel sheet and tight–fit metallic lid. Two numbers of perforated containers of size 0.5m x 0.75m x 0.5m each of holding capacity of 75 kg of rhizomes made of 2mm thick perforated mild steel sheet are placed on a stand on L angle. Perforated containers are provided with lifting hooks to facilitate easy lifting of the containers. The whole unit weighs about 125 kg.

The cleaned rhizomes are loaded in the two perforated containers. The outer container is filled with water to three-fourth of volume and sodium bi-carbonate is added at the rate of 100g per 100 litres of water. The perforated containers loaded with rhizomes are then placed in outer big container and heated form the bottom. As outer container is provided with tight lid, water boils well to cook/ boil rhizomes well. The complete cooking is made out by pleasant smell and soft nature of rhizomes which yield on pressing. The boiled rhizomes are unloaded and fresh batch of raw material is loaded in to the perforated containers to make use of hot water in the outer trough.

2. **Drying:** The boiled rhizomes are spread in sun for drying which take about 12 to 15 days for complete drying. Rhizomes are dried till they become hard, brittle and give metallic sound when broken. Only two laboureres will be sufficient for loading, unloading and fixing containers.
3. **Polishing:** The dried rhizomes are cleaned and polished in mechanically rotated drum or drum rotated by hand. Hexagonal wooden drum mounted on a central axis rotated by power can also be used for polishing the dried rhizomes.

The curing quality and the finally dried yield depend on variety. Generally, dried/cured turmeric is about 17-20 % of the fresh rhizomes. Mother rhizomes give higher curing percentage.

3.5 Polyclonal cultivation of local cultivars of banana as inter crop in coconut

Dr. S. Priya Devi
Email: priya@icargoa.res.in

Introduction

Banana is an important fruit crop of Goa cultivated in an area of 2,302 ha with a total production of 24,651 tonnes. There are seven local cultivars *viz.,* Amti, Velchi, Saldatti, Rasapali, Myndoli, Sugandhi and Savorboni cultivated in Goa. These are cultivated either as monocrop or intercropped in coconut or arecanut plantations to a limited extent in different places of Goa. Intercropping banana in coconut interspaces is a profitable venture recommended in many places in India like Kerala and in other countries like Sri lanka and Philippines.

Technology

Improved package of practices for cultivation of local cultivars of banana under coconut shade was standardized. Considering duration for flowering and fruiting, propping needs and market, cultivation of two or more cultivars like Myndoli, Grand Naine, Velchi and Amti under coconut shade will be highly remunerative to the farmers of Goa.

Therefore, polyclonal culture i.e., cultivation of two or more chosen cultivars from the above group *ie.*, Myndoli + Grand Naine+ Velchi or Savarboni + Amti + Velchi or Raspali + Amti + Velchi or Saldatti + Amti + Velchi (or) cultivation of Grand Naine + Velchi along with any other local variety of regional preference under coconut shade will be highly remunerative to the farmers.

Planting material

Suckers of local banana cultivars evaluated are available with all banana growing farmers and each sucker is sold @Rs.8-10.

Cultivation of banana as intercrop in coconut

Expected Impact of the technology

Scientific cultivation of local cultivars of banana will improve the area and production of banana in Goa. It is also a profitable venture to the coconut planters. The area under coconut cultivation is around 26,000 ha. Even if 50 percent of the interspace is brought under cultivation of banana, the state production is likely to increase four folds *ie* at the minimum to a tune of 80,000 t/ year.

Economic output of the technology

Cost: benefit ratio for main and two ratoons is higher in Raspali (1: 2.21), Savarboni (1: 2.31), Myndoli (1: 2.47) and Grand Naine (1: 2.48) followed by Amti (1: 1.95), Saldatti (1:1.85), Velchi (1: 1.67) and Sugandi (1:1.15).

Therefore, an average additional profit of Rs. 50,000 /ha/year is guaranteed.

Bunches of recommended local cultivars

Amti

3.6 Pineapple- A profitable intercrop in coconut

Dr. S. Priya Devi
Email: priya@icargoa.res.in

Introduction

Although coconut is one of the important plantation crops cultivated in Goa in an area of 26,000 ha, the inter-space is fallow in 90% of the fields. Presently, indescript 'Local' cultivar is grown in slopes under shade of forest trees as well as coconut. These plantations are in neglected state being continued for more than 5 to 6 ratoon crops without any fresh planting resulting in poor yields *i.e.* 8-10 tonnes/ha.

Technology developed

Improved package of practices for cultivation of varieties of pineapple under coconut shade has been standardized. Cultivation of 'Giant Kew' pineapple is economical due to higher yields and very less disease and pest incidence under agro-climatic conditions of Goa. Ratooning resulted in considerable decrease in yields and hence fresh plantation is recommended after second ratoon crop.

Economic output of the technology

The estimated income from main crop of 'Giant Kew' variety grown in coconut plantation would be around Rs. 3 to 4 lakhs from one hectare

Cultivation of pineapple as intercrop in coconut

(@49.27 t/ha and Rs. 8/- per kg average wholesale price for pineapple during 2007-08; NHB). In first and second ratoon crops, income would be Rs. 2-3 lakhs and Rs. 1 lakh from 36.84 and 16.88 tonnes /ha yield, respectively. This is an additional income besides regular income from coconut. The additional side suckers and slips produced also fetch margin to the farmers. The cost of suckers varies from Rs 2 to Rs 4 per sucker.

Expected Impact of the technology

Scientific cultivation of improved cultivars of pineapple will enhance the area and production of pineapple in Goa. Pineapple biomass like leaves and crowns can be utilized for composting and recycling nutrients thus reducing fertilizer costs. If possible, pineapple biomass can be a better and easier material to extract bio-ethanol than from other sources like algae and fish biomass.

Planting material

Suckers of improved varieties of pineapple *viz.,* Giant Kew and Mauritius are available in large scale at Pine apple farms owned by Mr Abdul Rauf, Sirsi,Uttar Kannada(Dt), Karnataka

Fruits of improved varieties of pineapple under coconut plantation

3.7 Promising early bearers of kokum in Goa

Dr. S. Priya Devi
Email: priya@icargoa.res.in

Introduction

Kokum is an important native crop found naturally in area of around 1200 ha with 10200 tonnes of fruit production in Goa. The important product is the dried rind of kokum which is sun dried and preserved for the ensuing year. The bearing season of kokum coincides with summer. Studies conducted in Goa shows that around 61 % of the existing population are late bearers (June- July; more than 2/3rd of fruits are ready only during rains), 25 % are mid season bearers (May-June; more than 2/3rd of harvest before on set of monsoons) and only 14 % are early bearers (April-May; the total produce can be dried and stored before onset of monsoon).

Expected Impact of the technology

These early bearers are good yielders too especially Parashte-3 and Gola-1. The mass multiplication of these early types by grafting and cultivation in large scale will result in reduction in fruit loss and enhancement in the production of value added products. This not only increases the income of growers but also prevents the nutritional drain of this important crop.

Planting material

Mass multiplication has been initiated in the institute by taking scion material from the identified promising mother trees.

Technology

Identification of early types of kokum

S.No	Name of Accession	Taluk / Zone	Fruiting season	Fruit weight (g)
1	Savoi kamini - 1	Ponda	Feb to March	45-50
2	Pednem Keri - 1	Pernem	Mid March to Mid May	50 -55
3	Parashte - 3	Pernem	Mid March to Mid May	50 -60
4	Gola - 1	Bicholim	Early March to Early May	50-55
5	Mashem - 4	Canacona	Early March to Early May	50-55
6	Pedem - 3	Canacona	Mid March to Mid May	50-60
7	Hedode - 1	Sattari	April-May	45-50

Early bearer-Savoi Kamini


Dried rind

3.8 Protected cultivation of gerbera cut flower under naturally ventilated polyhouse

Dr. M. Thangam
Email: thangamgoa@gmail.com

Introduction

Horticulture is an important sector in agriculture in Goa. More than 60 per cent cultivable area in Goa is under horticultural crops. The total area under horticultural crops during 20011-2012 was 1,03,401 hectares with a total production of 1, 86,557 tonnes with 129.28 million nuts from coconut.

Floriculture is highly neglected field and its proportion towards other horticulture crops is less than one percent. The area under floriculture is hardly 25 ha with the production of 40 tonnes per year. But the climate is highly suitable for many cut flowers, loose flowers and cut foliage. Hence, standardization of production technology for cut flower production was initiated at ICAR Research Complex for Goa, Old Goa.

Technology:

Varieties identified under Goa condition:

- Dalma
- Dana Ellen
- Rosalin
- Savannah
- Blessings
- Forza
- Scope
- Malibou

(**Source**: KF Bio plants Pvt. Ltd. Pune)

Varieties evaluated under Goa condition

Stages of Gerbera cultivation its polyhouse




Generally gerbera starts quality bloom production from third months after planting when the plants are with 15-20 leaves. The average yield is 40-50 flowers per plant per year depending on the variety. Immediately after harvest, flowers are kept in water for good shelf life. Later individual flowers are packed in polythene bag of size 4.5"x4.5" to make bundles of 10 flowers each.

Cost economics

Cultivation of gerbera under naturally ventilated polyhouse in Goa is very much profitable due to ever increasing demand for flowers especially during peak tourist season. At the end of one year, a net income of 0.39 Lakhs in 500 m^2 can be realized after deducting the entire fixed cost.

Exptected impact of techonology

Local cultivation of gerbera will boost the cut flower production in Goa. At present most of the cut flowers are imported from the neighbouring states.


Freshly harvested flowers ready for marketing

3.9 Protected cultivation of anthurium cut flowers under naturally ventilated polyhouse

Dr. M. Thangam
Email: thangamgoa@gmail.com

Introduction

Anthurium is one of the beautiful cut flowers cultivated mostly in tropical humid climate and hence it has good scope for cultivation in Goa. Anthurium cultivation has been catching up in India especially in the Western Ghats and the North Eastern region. A number of farmers and coffee planters of Western Ghats of Karnataka and Kerala have adopted anthurium cultivation as a hobby which got transformed in to a commercial enterprise. It is ranked eleventh in the global cut flower trade next only to orchids among the tropical flowers. The preference for colours in global as well as domestic markets for anthurium flowers indicates that the red coloured varieties are the most favoured with 45 per cent share followed by pink and white coloured types.

Hence, standardization of production technology for cut flower production was initiated at ICAR Research Complex for Goa, Old Goa.

Technology

Varieties identified under Goa condition:

- Aymara
- Chichas
- Ivory
- Elan
- Jewel

(Source: KF Bio plants Pvt. Ltd. Pune)

Anthurium varieties evaluated in Goa

View of Anthurium varieties under polyhouse

Anthurium flowers are harvested when the spathe completely unfurls and the spadix is well developed. Development of true flowers on the spadix is also used as a criterion for harvesting the blooms. When one third of the true flowers on the spadix mature, change of colour can be observed that moves from base to tip of spadix and that is the right stage for harvesting of flowers.

Flowers are ready for harvesting after 8-10 months of planting. Average yield is 5-7 flowers per plant per year for initial two years and 10-12 flowers per plant per year from 3rd year onwards. Leaves of anthurium can also be sold at a reasonable price.

Flowers are harvested with long (50-60cm) stalks. Harvested flowers are kept in water immediately to prevent wilting. For long distance transport, a piece of water soaked cotton is placed at the cut end with rubber band. Appropriate size polypropylene or polyethylene bag is used to cover the spathe and spadix of each flower to prevent bruising of spathe. Open end of the bag is stapled.

Flowers are graded as Extra large, Large, Medium, Small and Mini sizes. Flowers are packed in card board boxes measuring 60 cm (L) x 30 cm (W) x 22cm (H) keeping flower spathes on both sides to utilize the space.

Frestly harvested Anthurium packed in polyhouse for transport

Cost Economics

Yield and returns (100 m² /year)

Year	Flowers/ plant / year	Flower yield per m²	Flower yield/ 100m²	Selling price (Rs)	Returns per Year (Rs.)
2nd	5	35	3500	10	35,000
3rd	6	42	4200	10	42,000
4th	8	56	5600	10	56,000

3.10 Coloured capsicum cultivation under naturally ventilated polyhouse

Dr. M. Thangam
Email: thangamgoa@gmail.com

Introduction:

Horticulture is an important sector in agriculture in Goa. More than 60 per cent cultivable area in Goa is under horticultural crops. The total area under horticultural crops during 20011-2012 was 1,03,461 hectares with a total production of 1,86,551 tonnes and 129.28 million nuts from coconut.

In Goa, the area under vegetable crops during 2011- 12 was 6,498 ha with the annual production of about 78,201 tonnes. The average productivity works out to be around 12 tonnes per hectare which is low compared to national average of 15 tonnes/hectare Hence, standardization of production technology for capsicum production was initiated at ICAR Research Complex for Goa, Old Goa.

Technology

Hybrid / varieties recommended for Goa conditions are:

- Bombi (Red)
- Orobelle (Yellow)
- Indra (Green)
- Swarna (Yellow)

(Source: Syngenta India Limited, Amar Paradigm, S.No.110/11/3, Baner Road, Pune- 411 045)

Capsicum cultivation under polyhouse

Stages of capsicum cultivation in polyhouse






Yield and economics of colored Capsicum:

Cost economics for 1000 m²:

Total fixed cost	4, 43,000
Recurring cost	
Shadenet	16,000
Polysheet	62,000
Consumables	25,680
Every season	30,742

Hence the estimated cost of production: Rs.10/kg

3.11 Baby corn and sweet corn cultivation technology for Goa

Dr. K. Ramachandrudu and Dr. M. Thangam
Email: thangamgoa@gmail.com

Introduction

Goa is a vegetable deficit state even though more than 60 per cent cultivable area in Goa is under horticultural crops. In Goa, the area under vegetable crops during 2011-12 was 6,498ha with the annual production of about 78,201 tonnes. The average productivity works out to be around 12 tonnes per hectare which is low compared to national average of 15 tonnes/hectare. In addition to existing crops, introduction and evaluation of new high value crops is an important strategy to increase production and to meet the market demand.

Important crops cultivated are sweet potato, brinjal, okra, cucurbits, chilli, cluster bean, radish, amaranthus, other tuber crops etc. Cultivation of capsicum under polyhouse is a new technology in Goa.

View of sweet corn crop in field

Technology:

Varieties/hybrids recommended:

Sweet Corn: Sweet Pearl, Golden Honey

Baby Corn: Golden Baby, G-5406, Mridula

Season of cultivation:

During Kharif on slopes and during rabi with protective irrigation

Stage of harvest:

Baby corn: Just emergence of silk from the cob

Sweet corn: Drying of silk in the cob

Seed Source:

Syngenta India Limited, Amar Paradigm, S.No.110/11/3, Baner Road, Pune- 411 045

Baby corn and Sweet corn cobs

Crop	Varieties recommended	Net income (Rs. /ha)
Sweet corn	Sweet Pearl, Golden Honey	75,000/-
Baby corn	Golden Baby, G-5406,Mridula	51,400/-

Expected outcome

Cultivation of new high valuable crops like sweet corn and baby corn will fetch premium price in the market. Generally these vegetables are procured from neighboring states. In addition, diversification of existing vegetable cultivation with high value crops will supplement the income generation of marginal farmers.

3.12 Lilium cut flower production under naturally ventilated polyhouse

Dr. M. Thangam
Email: thangamgoa@gmail.com

Introduction

In Goa, presently loose flowers viz., marigold, jasmine, crossandra etc. are cultivated under open field condition during *rabi* season. But, Goa climate is highly suitable for many cut flowers, loose flowers and cut foliage but floriculture is a highly neglected field and its proportion towards other horticulture crops is less than one percent. Cultivation of lilium under polyhouse will be cost effective and suitable for Goa

Technology standardized

Hybrids suitable for Goa:

1. Courier (white)
2. Brindisi (pink)
3. Serrada (yellow)
4. Brunello (orange)

Different introduced hybrids of lilium

Source for corms:
M/s. KF Bio plants Pvt. Ltd.
Pune

Technology for cultivation of lilium cut flower under naturally ventilated polyhouse was standardized. The crop can be cultivated throughout the year. Cut flowers with good quality flowers along with long stems can be produced under the polyhouse with required fertigation and plant protection schedule.

Cost economics

The major cost of production is towards the structure and planting material. Farmers can avail subsidy up to 50 percent of the cost of the project under NHM. The bulbs once used can be reused for next crop with proper storage and management.

Cost of cultivation and income:

Area	500 m^2
Plant population	70,000
Spacing	30x30 cm
Planting material	Corms (2.5-3cm) @ Rs.10 / corm

Cost benefit ratio

1st year	1:1.5
2nd year	1:4.0

Expected impact

Lilium cut flower production will help in farmers to diversify the cropping system and additional income.

Flowering in lilium under poly house condition

3.13 Production technology for Gladiolus cut flower

Dr. K. Ramachandrudu and Dr. M. Thangam
Email: thangamgoa@gmail.com

Introduction

Gladiolus is an introduced crop to the state of Goa. Corms of improved varieties were imported from Holland and supplied to the farmers under centrally sponsored schemes on floriculture. But, farmers have given up cultivation due to non availability of corms in the subsequent seasons. Hence, production of corms as well as cut flower will be an ideal option for farmers to get additional income. Secondly farmers used to cultivate only during winter season.

Technology

Varieties suitable for Goa

- Wigs Sensation
- Rose Supreme
- Peter Pears
- Nova Lux
- Dhiraj
- White Prosperity

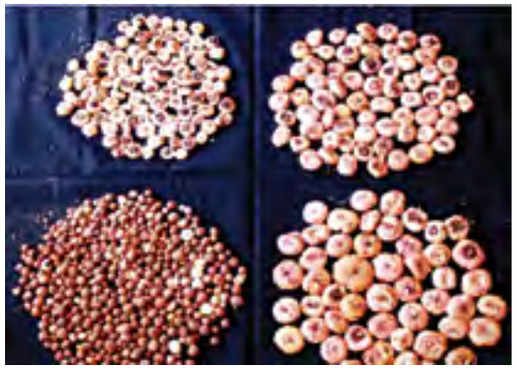
Low cost storage of corms was standardized for short term storage since availability of corms for the next season is a problem. Study indicated that corms stored in sand, saw dust and soil stored up to 6 months with viability.

Size of the corms on plant growth and flower production was standardized. In general jumbo size corms produced long flower with maximum corm weight. For commercial cultivation uniform sized corms are recommended to get uniform flowering and quality.

Spacing for Gladiolus

Different spacing was evaluated under open field condition. Among

Gladious varieties suitable for Goa



Grades of corms used for planting

the treatments tested, the convenient and optimum spacing for Goa is 40x20 or 45x20 which can accommodate 1.25 lakhs plants/hectare.

Studies on manurial requirement, growth regulator and dormancy of corms resulted in development of entire package of practices for cultivation of gladiolus under open field condition in Goa.

Performance of gladiolus under field condition

Cost economics

Area	1000 m^2
Plant population	1, 25,000/ha
Spacing	40x20cm
Planting material	Corms (2.5-3cm) @₹2.5/corm

Cost benefit ratio	
1st year	1:1.9
2nd year	1:5

3.14 Extension of vase life of Lilium cut flowers

Dr. Safeena S.A, Dr. M. Thangam and Dr. S. Priyadevi
Email: safeenasandeep@gmail.com

Introdution

Currently there is no commercial cultivation of any cut flower in Goa. Successful technologies have been developed in the Institute for commercial cut flower production of Lilium under naturally ventilated polyhouse in Goa. Prolonged vase life is one of the most important factors for quality of cut flowers, and hence post harvest management plays a key role in enhancing vase life of cut lilies. Currently the imported flowers are pulsed by the florists in ordinary water whose shelf life is hardly six days.

Technology

Three cultivars *viz.* Courier (White), Brindisii (Pink) and Serrada (Yellow)were subjected to six chemical treatments. All the preservative solutions viz 8-HQC (200 ppm) Floracare (1000 ppm), $AgNo_3$ (50 ppm), Citric Acid (50 ppm) and BAP (50 ppm) were supplemented with 3% sucrose except in control.

Brindisii had a longer vase life of 9.47 days than the other two cultivars. Among the chemicals, silver nitrate (50 ppm) + 3 % sucrose was the most effective in all three cultivars, and can be

used to prolong vase life, delay leaf senescence and enhance post-harvest keeping quality of *Lilium* cut flowers.

Expected impact of technology

As most of the flowers are being imported from neighbouring states like Karnataka and Maharashtra, the florists incur a high cost towards flower as well as freight charges.

Due to perishable nature of the Lily, the flowers need to be imported four to five times a month.

If flowers are pulsed in recommended dose of Silver nitrate and shelf life prolonged, the flowers need to be imported only two to three times a month. This will cut down the cost by 40-50 %.

Animal Sciences

4.1 Technology for management of bovine mastitis

Dr. S. B. Barbuddhe
Email: barbuddhesb@yahoo.com

Introduction

Mastitis or inflammation of mammary gland or udder is an economically important condition in milking animals. Mastitis is a disease that affects a large number of dairy cattle. It may affect one or all quarters of the udder. If one quarter is affected 25% milk yield is lost permanently. High yielding animals are more prone to this condition, if not milked properly. The milk from infected udders contributes to high microbial counts of milk, which in turn is not suitable for preparation of milk products. Subclinical form of mastitis is considered world-wide to be the most persistent and widespread complex of diseases of importance to milk hygiene. Subclinical form occurs 20-50 times more frequently than the clinical forms and cause greater losses, although it cannot be recognized unless applying particular methods of examination. Mastitic organisms are also pathogenic for human beings. Mastitis control is prerequisite to any of the clean milk production programmes.

Technology

To diagnose mastitis, it is necessary to learn how to distinguish between the symptoms of the various types of mastitis infection. Subclinical cases may go unnoticed and therefore testing of milk with California mastitis test (CMT) or any other spot test is necessary. Bacteriological examination of CMT positive samples should be carried out. Diagnosis of mastitis is based on bacteriological and cytological methods of examination. For bacteriological examination, milk samples need to be collected under aseptic conditions and should be preserved under refrigeration.

Cow suffering from mastitis

Mastitis control also entails a good understanding of the factors that encourage its incidence and the microorganisms that cause it. Mastitis control must be concentrated

on the prevention aspects, which depends mainly on the whole hygienic management and absence of stress conditions. Specific control measures need to be taken according to the respective cause and the extent of losses. Specific control measures include -

1. Correction of milking technique
2. Teat disinfection (e.g. teat dipping) following milking.
3. Antibiotic treatment at drying off
4. Culling of animals with therapy - resistant mastitis.

Estimation of cost

The major cost of the interventions involve

Cost for detection of mastitis: Rs 25 per animal

Cost of laboratory analysis of samples for subclinical mastitis and antibiotic sensitivity: ₹ 100/sample.

Cost of treatment of animals affected: Rs 100/animal

Benefits envisaged

By following the package an improvement in health of animals and in turn production of clean milk is envisaged. The benefits are both tangible and non-tangible. Additionally, human health can benefit from supply of healthy milk. Mastitis is severe limiting disease in dairy production. Good farming practices will underpin the marketing of safe quality assured milk and milk products and promote assurance to the consumer.

Table -1: Additional income generation with the adoption of technology package

Technology	Investment	Production potential	Potential income generation
Non-antibiotic control of mastitis	₹ 1000 /animal /lactation	3000 lit/lactation	₹ 48000/lactation
Low cost detection of subclinical mastitis and its control	₹ 100/animal/ lactation	3000 lit/lactation	₹ 48000/lactation

4. 2. Quality assurance and monitoring of dairy foods

Dr. S. B. Barbuddhe
Email: barbuddhesb@yahoo.com

Introduction

Production of milk and its products involves a long sequence of operations from harvesting to final consumption during which it is exposed to various microorganisms. The climate in Goa is very congenial with high humidity and relatively constant temperature throughout the year which in turn favours the rapid multiplication of the microbes in foods of animal origin.

The microbial growth is undesirable as it may cause spoilage as well as food-borne illnesses. Clean milk production results in milk that is safe for human consumption and free from disease producing microorganisms, has a high keeping quality, can be transported over long distances, has a high commercial value and is a high quality base product for processing resulting in high quality finished products.

An efficient hygiene programme should begin at the farm. Essentially milk hygiene practice has interests in preventing the transmission of disease from animals to man, preventing the transmission of communicable diseases of man through milk.

Technology

Good quality raw milk must be:

a. Free from debris and sediment.
b. Free from off-flavours.
c. Low in bacterial numbers.
d. Normal composition and acidity.
e. Free of antibiotics and chemical residues.

Good hygiene is essential whether the animals are milked by hand or machine. This requires that:

Cleaning of udder before milking

Dipping of teats after milking

a. The milkers' hands and clothes are clean and he or she is in good health.
b. The milking machine and milk storage equipment such as milk churns are kept clean and are in good condition.
c. Immediately after milking, the milk must be cooled preferably to 4^{O}C. This requires mechanical refrigeration or milk cooling tanks.

Estimation of cost

The major cost of the interventions involve

Cost for arranging awareness campaigns:

Cost of sanitizers for demonstration purposes;

Cost of consumables for laboratory analysis of samples to study the impact of the technology adopted:

Benefits envisaged

One of the most important measures is the introduction of a Quality Linked Price Incentive paid to the village cooperatives for the supply of raw milk. By following the package an improvement in health of animals and in turn production of clean milk is envisaged. Additionally, human health can benefit from supply of healthy milk.

Table :- Additional income generation with the adoption of technology package

Technology	Investment
Intervention in cleanliness of surrounding of animals (animal itself, floorings, shed, milking utensils)	₹ 100 / animal/lactation
Quality monitoring of milk and milk products before and after intervention	₹ 100/sample

4. 3. Monitoring and surveillance of economically important livestock diseases

Dr. S. B. Barbuddhe
Email: barbuddhesb@yahoo.com

Introduction

Diseases reduce the production potential of livestock. There are a number of diseases such as foot and mouth disease (FMD), hemorrhagic septicemia (HS), brucellosis, tuberculosis, and black quarter (BQ) that affect livestock production and cause enormous economic losses. An estimated livestock output worth Rs 50 billion is lost annually due to disease. Livestock development programs cannot possibly succeed unless a well organized animal health service is built up and protection of livestock against diseases and pests, particularly the deadly infectious ones, is assured.

The diagnosis of specific diseases requires laboratory investigations which can be done at Veterinary Diagnostic laboratories.

The control of various health problems can be built into a quality assurance system on a farm. The aim is to prevent an infectious disease to enter a farm or eradicating or managing a disease that is on the farm. The majority of the economically important diseases can be prevented by way of vaccination.

Estimation of cost

The major cost of the interventions involve. Cost for vaccinations against major diseases:

Cost of monitoring and surveillance;

Benefits envisaged

Diseases reduce the production potential of livestock. By following the package an improvement in health of animals and in turn production of clean milk is envisaged. Some of the diseases are of zoonotic importance. Loss of animals on account of diseases is a huge economic loss to the farmers.

Cow with swollen joints suffering from brucellosis

Additional income generation with the adoption of technology package

Technology	Investment
Vaccinations against major diseases (HS, BQ, Enterotaxaemia, FMD)	Rs 100/animal/year
Monitoring and surveillance of major diseases	Rs 500/animal/lactation

4.4 Monitoring and surveillance of emerging infections

Dr. S. B. Barbuddhe
Email: barbuddhesb@yahoo.com

Introduction

Foods of animal origin are an ideal medium for the growth of both pathogenic and spoilage microorganisms. Although milk and milk products are among the safest worldwide, the potential for foodborne illness is a major concern to producers, processors, regulators, and consumers. Recent changes in demographics, lifestyles, and in the food system (e.g., complex, large-scale production and broad distribution) itself are creating new challenges to ensuring food safety.

Technology

There are a number of emerging and re-emerging microorganisms of concern to the dairy industry that must be controlled during and after processing. Microorganisms of concern include *Listeria monocytogenes, Salmonella, Escherichia coli* O157:H7, *Staphylococcus aureus, Yersinia enterocolitica, Bacillus cereus*, *Clostridium botulinum, Mycobacterium bovis, Brucella abortus*, and *Brucella melitensis*.

Estimation of cost

The major cost of the interventions involve

Cost for detection of the pathogens in food chain:

Cost of sanitizers for demonstration purposes to reduce the incidence;

Cost of consumables for laboratory analysis of samples to study the impact of the technology adopted:

Benefits envisaged

By following the package an improvement in health of animals and in turn production of clean milk is envisaged. Additionally, human health can benefit from supply of healthy food.

Epidemiological sur-

veillance should be applied to the increasing list of classical and re-emerging zoonoses so as to avoid contamination of the product from exo- and endogenous sources in different production stages. An integrated approach to veterinary public health involving both veterinary and health authorities is required to assess the risk of milk- and other foodborne illnesses on the different risk categories of patients.

Additional income generation with the adoption of technology package

The benefits envisaged through monitoring of the emerging infections are non-tangible.

Technology	Investment
Detection of the pathogens in food chain	Rs 400/sample

4.5 Cross bred pig for better pork production

Dr. E. B. Chakurkar
Email: eknchakurkar@yahoo.com

Introduction

Goa, a small state of the country is mainly recognized as a tourist place. The major population of the state is omnivorous preferring meat in day to day food. Pork contributes to major extent in their diet in the form of fresh/frozen meat or as sausages. For the pork and pork products local non-descriptive animals reared under the scavenging condition are the major source. However, the production potential of the pure local animals is very poor. At the same time, the maintenance of pure exotic breeds like Yorkshire under field condition is not successful. Exotic pigs grown under intensive system have more lard as compared to local pigs reared under free range system. The maximum demand is for lean meat for health point of view.

Technology

Crossbreed pig (large white Yorkshire x local), is suitable for lean meat production in local condition.

Crossbred pig rearing in local situation

Characteristics of (Local x Yorkshire) pig

Birth weight	:	300-700g, Weaning weight (60 days) 6.0-7.5 kg
Age of Puberty	:	190-210 days, Age of Maturity 230-240days
Marketable age (55-60 kg)	:	7-8months, Dressing percent 80 - 82 %
Average back fat thickness	:	4.6 cm.

Benefit envisaged

A very important characteristic of meat i.e. back fat thickness was significantly less in crossbreed than local and Yorkshire breeds.

As the crossbred pigs attain around 60 kg body weight by 7 months of rearing, the farmer will get additional 30 kg body weight compared to local pigs. Therefore an additional income of Rs. 2000/- can be expected by growing one crossbred pig.

Source of the breed

ICAR Research Complex for Goa.

4.6 Rabbit production technology

Dr. S. K. Das
Email: das@icargoa.res.in

Introduction

Rabbit is suitable in wide range of climatic condition. Due to wide genetic variation there is wide scope for genetic improvement. As they require less space, so housing cost is also less. Rabbit is herbivorous so they don't depend on concentrate feed for maintenance. Due to their coprophagic feed habit, requirement for protein and energy is less. So, feed cost is less. As they are induced ovulator they can be bred throughout the year. One rabbit doe can produce 20-25 kits in a year. Since rabbit has short generation interval, they can be produced at least four times in a year. Hence, capital of a farmer rotates throughout the year. Rabbit produce best quality white meat having high protein, low energy and low cholesterol. There is no social prejudice for consumption of rabbit meat.

Technology

- Rabbit is basically animal of sub-temperate climate. Breeds for broiler rabbit production prefers ambient temperature of 15 -20 ^{0} C and a relative humidity of 65 –75 %. New Zealand White and Soviet Chinchilla were found to be suitable breed for broiler rabbit production.
- Out of four types of tested housing systems, indoor cage housing was found to be best in respect of productivity.
- Individual rearing is found to be better than group rearing in respect of productive and reproductive performance.
- Floor space requirement for different classes of rabbit was tested, standardized and it was found to be 1 sq ft for weaner, 1.5 sq ft for grower, 2.0 sq ft for finisher, 2.5 sq ft for adult and 3.5 sq ft for nursing mother.
- Weaning should be done at the age of 6-7 weeks. To overcome stress one course of deworming by sulmet and one course of calcium by ostocalcium feeding is necessary. After weaning sexing and identification is needed.
- Feed requirement for weaner - 50g, grower - 75g, finisher-100g, adult-125g and nursing mother 200g. Feed should contain at least 16-18 % CP and 10-12 % CF.
- Age of breeding in male and female is 7 and 6 months respectively. Selective breeding should be

practiced and selection should be done based on growth and carcass traits in male and on litter size at birth and litter weight at birth in female.

- Age of slaughter and marketing should be 90-100 days as at this age best quality meat is available besides fur skin.

Productivity

- Average growth was found to be 20 - 25g /day depending on housing, feeding and management.
- Number of crops per year per mother (Doe) is 4 -5.
- Average litter size at birth is 6 - 8.
- Average litter size at weaning is 5 –7.
- Live weight at marketing is 1.7 – 1.8 Kg.
- Dressing % of rabbit is 55 - 65 %.

Benefits Envisaged

Farmers of North Goa and South Goa are rearing rabbit economically and they are getting benefit from rabbitry. Each rabbit is being sold @ Rs 300- 400/- depending on size.

Sources

ICAR Research Complex for Goa, Old-Goa, Goa ; CSWRI, Avikanagar and ICAR Research Complex for NEH Region, Barapani, Meghalaya.

New Zealand White - most adaptable rabbit breed for meat production in Goa

Soviet Chinchilla - another popular meat breed of rabbit in Goa

4.7 Synchronization of estrus and timed insemination

Dr. E. B. Chakurkar
Email: eknchakurkar@yahoo.com

Introduction

Breeding is carried out when the animal is coming to estrum naturally. Estrus detection requires daily observations for the appearance of estrus signs such as vulval edema, vaginal discharge, estrus grunt, mounting behavior etc. Estrus detection in animals requires skill to identify the animals in estrus, since estrus in some animals is silent in nature. If these animals left undetected and their cycles are missed without breeding, will increases the inter calving period and cause economic loses to the farmers.

Technology

Estrous synchronization programs mainly involve the luteolytic agent prostaglandin. Prostaglandin is able to synchronize the cycle by inducing regression of corpus luteum. As prostaglandin is effective only during diestrum period, a double injection protocol of prostaglandin at 11 to 14 days interval is practiced to synchronize most animals. Progesterone based protocols for estrous synchronization is appropriate for non-cyclic or anoestrous post partum animals. Prostaglandin is ineffective in these animals, because of the absence of a mature corpus luteum. The ovulation synchronization program (Ov synch) based on the use of GnRH, prostaglandin is to coordinate follicular recruitment and the time of ovulation is followed in Bovines.

Benefits

Estrous synchronization is carried out to reduce the labour and time involved in estrous detection, to overcome the problem of silent estrus, for effective use of superior sires to most of cows, and adaptation of technologies like artificial insemination and embryo transfer technique, etc.

4.8 Technology for production of bypass fat indigenously for feeding of dairy animals

Dr. Prafulla Kumar Naik
Email: pknaikicar@gmail.com

Introduction

Bypass fat (rumen protected fat) is the dietary fat, which is not degraded in the upper part (rumen) of the digestive tract, but gets digested in the lower part of the digestive tract of the dairy animal and therefore is the best choice 'energy rich feed supplement' to increase the milk production of the dairy animals. This technology involves the use of low cost vegetable (palm, rice bran etc.) fatty acid oil (by-product of vegetable oil refinery industry) and technical/ commercial grade calcium oxide/ calcium hydroxide.

This technology for production of bypass fat indigenously is simple, user friendly, does not need sophisticated equipments and can be easily prepared by the small and marginal farmers as per the daily requirement. Besides, as the product remains in solid form, it can be effortlessly mixed with the other feed ingredients and easily transportable.

Technology

- Bypass fat (Ca-LCFA) is prepared by treating vegetable (palm/ rice bran) fatty acid oil, the by-product of the oil refinery industry and technical grade calcium hydroxide/ calcium oxide under specific conditions.
- The indigenously prepared bypass fat contains about 70-75% fat and 7-8% calcium.
- The indigenously prepared bypass fat is kept in air tight container in cool place after mixing with butylated hydroxy toluene @ 0.05% as an antioxidant.

Indigenously prepared bypass fat

Feeding of by pass fat to dairy animals in farmer's field

Release of indigenously prepared bypass fat by Dr. A. K. Singh, Ex-DDG (NRM), ICAR

Benefits

- This technology for production of bypass fat indigenously is very cost effective and affordable.
- From 10 kg fatty acids and 4.0 kg calcium hydroxide/ calcium oxide, approx. 14 kg bypass fat is produced in short time, costing approximately half of the market price.
- Supplementation of the indigenously prepared bypass fat @ 15-20 g/ kg milk production increases the milk yield up to 20% giving an additional profit of approximately ₹ 10-30/ animal/ day.
- Feeding of the indigenously prepared bypass fat improves the fertility and body conditions of the dairy animals.

4.9 Brewers' spent grains (BSG) feeding technology for livestock

Dr. Prafulla Kumar Naik
Email: pknaikicar@gmail.com

Introduction

Brewers' spent grains (BSG) are the by-products of the brewing industries, obtained during the preparation of cereal malt beverages. The BSG primarily consist of residues of the grains (barley alone or a mixture of barley and other cereal grains or grain by-products) used in the brewing process.

In Goa, about 6000 tonnes of BSG are produced annually of which 50% is used in the state and the rest is being exported to the neighbouring states. The fresh BSG contain about 80% moisture and after drying the brewers' dried grains (BDG) contain approximately 25% crude protein, 5% ether extract, 17 crude fibre, 7.5% total ash and 1.5% acid insoluble ash on dry matter basis. BSG can be used as an alternative feed for livestock to reduce the cost of production. In dairy animals, the BSG can be fed both as fresh brewers' grains and brewers' dried grains (BDG).

Technology

- After procuring the BSG, keep it in a place with slanting floor so that the excess water will be drained out.
- Due to high moisture content, BSG cannot be preserved as such for long time (not more than 4-5 days). However, after sun drying, it can be preserved for long duration.

Brewers' spent grains (fresh)

Sun drying of BSG,
known as brewers' dried grains (BDG)

- It is suggested that on fresh basis BSG can be fed daily @ 2% of the body weight of the dairy animal replacing about 2 kg of concentrate mixture.
- The BDG can be included in the diet of the dairy cows up to 25% replacing the rice polish without any adverse effect on the performance of the animals.
- BDG can be included in the starter and grower pig feed up to 20% and 25%, respectively replacing partially maize, rice polish and soybean meal without affecting the palatability, growth rate and feed conversion efficiency.

Benefits

- The cost of the fresh brewers' grains is about Rs.1.50/- per kg and the cost of BDG varies from Rs.6.0-7.5/- per kg.
- Feeding of BSG on fresh basis daily @ 2% of the body weight of the dairy animal replacing about 2 kg of concentrate mixture saves the feed cost approximately Rs. 20/- per animal per day.
- The inclusion of BDG in the diet of the dairy cows upto 25% replacing the rice polish reduces the cost of the concentrate mixture by approximately Rs. 3/- per kg.
- The inclusion of BDG in the starter and grower pig feed up to 20% and 25%, respectively replacing partially maize, rice polish and soybean meal reduces the feed cost by approximately Rs. 3-3.50/- per kg.

Feeding of BSG to dairy cows

Feeding of BDG to Pigs

4.10 Technology for production and feeding of hydroponics fodder for dairy animals

Dr. Prafulla Kumar Naik
Email: pknaikicar@gmail.com

Introduction

The major constraints in production of green fodder by dairy farmers are decreasing land holding size, high cost of land, scarcity of water or saline water, more labour requirement for cultivation (sowing, earthing up, weeding, harvesting etc.), requirement of manure and fertilizer, more growth time, non-availability of same quality green fodder round the year, high fencing cost to protect from wild animals, influences of natural calamities etc. As an alternative to conventional method of fodder cultivation, hydroponics technology is coming up for growing fodder for farm animals.

Green fodder produced by growing plants without soil, but in water or nutrient rich solution is known as hydroponics fodder or sprouted grains or sprouted fodder, which are generally produced in greenhouses within a short period.

Technology

- In this technology, maize is the choice fodder. However, other fodder crops like cowpea can also be produced.
- Under hydroponics technology, about 600 kg green maize fodder can be produced in the area of 50 sq. mt. only.
- The seeds should be soaked in tap water for 4 hours and then filtered and kept on green house trays.

Hydroponics fodder production unit

Trays containing hydroponics maize fodder inside green house

Release of hydroponics fodder by Dr. A. K. Singh, Ex-DDG (NRM), ICAR

- On 1st day, the trays containing the soaked seeds are put on the top most rows of the rack and then every day these are shifted to their respective below rows till they reach the down last row on 7th day and on 8th day, it is harvested and fed to the dairy animals.
- The hydroponics green fodder looks like a mat consisting of roots, seeds and plants and the whole biomass is fed to the dairy animals.

Hydroponics maize fodder for feeding of dairy animals

Feeding of hydroponics fodder to dairy animals

- Break the fodder matting into small pieces prior feeding to the dairy animals.
- It is suggested to feed 7-8kg hydroponics maize fodder to replace one kg concentrate mixture.
- It should be fed about 5-10 kg per animal per day.
- It is beneficial to feed the hydroponics fodder along with the other dry and non-leguminous green fodder to dairy animals.

Benefits

- About 5-6 kg hydroponics fodder with plant height of 20-30 cm is produced from one kg maize seed.
- In Goa condition, the cost of production of the fresh hydroponics maize fodder is about Rs. 4-4.50/- per kg in which the cost of the

Feeding of hydroponics maize fodder to dairy animals

seeds contributes about 90% of the total cost of production of the hydroponics maize fodder.

- In comparison to conventional green fodder, hydroponics fodders contain more crude protein, crude fat and nitrogen free extract; but less crude fibre, total ash and acid insoluble ash.
- Feeding hydroponics fodder to dairy animals increases the digestibility of various nutrients, particularly of crude protein and crude fibre.
- Feeding of hydroponics fodder to lactating cows daily causes about 13% increase in milk yield.
- Besides, the animals remain healthy with better skin coat and the reproductive efficiency is improved significantly.
- The technology has more social value as farmers in group can have a hydroponics green fodder production unit and share the hydroponics fodder produced from it as per their daily requirement.

4.11 Technology for preservation of green fodder by silage making

Dr. Prafulla Kumar Naik
Email: pknaikicar@gmail.com

Introduction

Silage making is a method of fodder preservation in its original form as far as possible and can be used when green fodder is not available in the farm for animal feeding. Silage is the material produced by the controlled fermentation of green fodder crop retaining the high moisture content. It may be called 'pickles of green fodder' for the dairy animals. The fresh fodder, when packed in a container and allowed to ferment under anaerobic condition produces some volatile fatty acids, which preserve the forage material for a long time with minimum loss of nutrients.

Technology

- In Goa condition, above ground level bunker type rectangular or circular cemented silo pits should be made.
- The number and size of the silo pits depends upon the number of animals, quantity of green fodder available with farm and availability of space in the farm. In Goa condition, it is suggested that many numbers of one cubic meter silo pits can be made due to less land holding size of the farmers.
- One cubic meter of pit can hold about 500 kg of green fodder.
- After harvesting, chop the non-leguminous fodder crops (maize or napier bajra hybrid) to the length of 8-10 cm and then spread in the pit uniformly.
- The moisture content of the plant during silage making is a very important factor. The desirable moisture content of the fodder should be 65-70%.
- The thumb rule for determining the optimum moisture content is to press a handful of chaffed fodder in hand palm. If the moisture content is appropriate, the hand will remain almost dry.
- Press the chaffed fodder with adequate trampling by manual labour.
- Cover the material with polythene sheet or if possibly by 10-15 cm straw layer followed by 5-7 cm layer of soil and then plaster it with mixture of clay and dung.
- Care should be taken that the fodder material on the sides and edges are properly compressed

Chaffing of green fodder

Filling of bunker type silopit by chaffed fodder

and raised, finally giving a tomb shape.

- The silage is ready for feeding to the animals after 40-45 days of sealing the pit. However, silage can be kept preserved for a long period if sealed properly.

Feeding of silage

- It should be opened from one side after removing the top layer of the covering.
- For optimum utilization of nutrients, milch cow should be fed 15-20 kg silage per head per day.

Silage characteristics

- The colour of good quality silage is greenish yellow or khaki.
- It should have vinegar smell.
- The texture should be firm.
- It should not have mould growth.
- It should be highly palatable and pleasing taste.
- The pH should be below 4.2.

Silage inside the bunker type silopit covered by polythene sheet

Feeding of silage to dairy animals

Precautions during silage making

- Care must be taken that if any crack or hole develops, then it should be plugged immediately to avoid entry of air or water into the pit.
- Immediately cover the open side with plastic sheets or gunny bag to avoid spoilage.
- Once the silo pit is opened, silage should be used daily to avoid any spoilage.
- Sometimes, too wet silage affects the flavour and odour of the milk, therefore, silage should be fed after milking.

4.12 Technology for rearing of backyard poultry Vanaraja (dual purpose bird)

Dr. B. K. Swain
Email: rbkswain@yahoo.com

Introduction

The product from native fowls is widely preferred specially because of their pigmentation, leanness, taste, flavour and suitability for special dishes. Only drawback of native fowl is lower production and slow growth. The growth and production can be improved by introduction of improved germplasm with better management. In this situation backyard poultry breed with an egg production capacity of 150-200 and 1.2-1.4 kg body weight at 10-12 weeks of age is viable in rural village condition. This production ensures the availability of poultry meat and eggs for the rural masses at cheaper rate which not only supplement the family nutrition and health but also provides supplementary income. The following technology adoption will meet the demand of farmers in rural areas to augment the income generation in addition to more employment generation.

Technology

The vanaraja day old chicks can be kept in nursery rearing up to 6 weeks of age with brooding for 3-4 weeks. Brooding can be done either on floor or in cages. After 6 weeks they can be reared in the backyard either for meat or for egg production. Body weights of -36.2g (day old), 585.6 g (6 wk), 1.36 kg (10 wk) and 1.75 kg (20 wk) can be achieved in the backyard. Besides, average ages at first egg (25 wk), egg production 32 week (68 %), egg production upto 72 weeks (120-150), average egg weight (55-56 g) and mortality in laying period (10 %) are the important features of Vanaraja laying hens. Housing can be provided as night shelter with locally available cheap materials like unused wire mesh, fish nets, bamboo and coconut leaves. Feeding can be done with household food wastes, vegetable waste, kitchen waste, insect pests, green grasses and fallen grains available in the backyard.

Brooding of Vanaraja chicks

Vanaraja in nursery

Management and health cover

During initial 4-6 weeks, the vanaraja chicks need brooding to maintain required body temperature. During this period they must be vaccinated against marek's disease and ranikhet disease. After 6 weeks they can be allowed to backyard for scavenging the free range area. During the initial acclimatization care should be taken to habituate them to reach the nest in the evening for night shelter. Night shelter should have proper ventilation, required light and protection from predators. Since, the chicks move in free range, there is possibility of parasitic infection. Therefore, periodic deworming at 2-3 month interval is required. For this purpose albendazole oral suspension (Albomar) can be given @ 3-5 ml/10 birds. Under backyard condition adult vanaraja birds should be vaccinated against ranikhet disease at six monthly interval. Since, there is a chance of transmission of diseases from native birds to vanaraja, vaccination of vanaraja along with native birds is suggested. White diarrhoea can be treated by giving Tetracycline powder in drinking water @ 1g/litre for 3-5 days. For better egg output and survivability, the weight of vanaraja should range between

Vanaraja adult birds

Vanaraja laying hens

2-2.5 kg. Excess body weight (> 3 kg) considerably reduces the egg production. The weight of vanaraja can be regulated to some extent through controlled feeding of cereals. The following vaccination schedule can be adopted for protection from prevalent diseases and keep the birds healthy for better production.

Cost involved and benefit envisaged

With an investment of Rs 60/ and Rs150/- per male and per female bird, net income was found to be Rs 45/- per male bird and Rs 260/- per female bird, respectively.

Source of the Breed

ICAR Research Complex for Goa, Old Goa, State Govt. Poultry Farm, Old Goa, Project Directorate on Poultry, Hyderabad, Andhra Pradesh.

Vaccination schedule

Age(days)	Name of the vaccine	Dosage	Route of administration
1	Marek's Disease	0.20 ml	Subcutaneous
7	Ranikhet Disease (Lasota)	one drop	Eye drop
18	Ranikhet disease (Lasota)	one drop	Eye drop
28	Ranikhet Disease (R2B)	0.50 ml	Subcutaneous or IM
42	Fowl Pox	0.20 ml	Intramuscular

4.13 Technology for rearing of backyard poultry Gramapriya for egg production

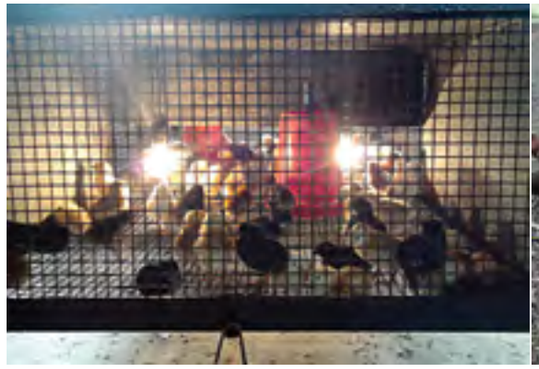
Dr. B. K. Swain
Email: rbkswain@yahoo.com

Introduction

The product particularly egg from native fowls is widely preferred specially because of the pigmentation, taste, flavour and suitability for special dishes. Only drawback of native fowl is lower egg production (40-60 per annum). The egg production can be improved by introduction of improved germplasm with better management. In this situation backyard poultry breed with an egg production capacity of 180-200 per annum is suitable under the backyard condition in rural village. This production ensures the availability of eggs for the rural masses at cheaper rate which not only supplement the family nutrition and health but also provides supplementary income since egg is well balanced in all essential amino acids. Further there is a special demand for brown eggs which resembles the deshi hen eggs. The following technology adoption will meet the demand of farmers in rural areas to augment the income generation in addition to more employment opportunities.

Technology

Gramapriya is an egg laying backyard poultry variety. The Gramapriya day old chicks are produced and they are brooded and reared in nursery up to 6 weeks of age. After 6 weeks of age they can be reared in the backyard for egg production. The male Gramapriya is kept on low density diet to attain optimum body weight for table purpose at the age of 10-12 weeks i.e. 1.0-1.2 kg. Female birds lay up to 180 eggs per annum under backyard condition with minimum input cost. Body weights of -36-39 g (day old), 540-550 g (6 wk), 950g-1.0 kg (10 wk) and 1.6-1.7 kg (20 wk) can be achieved in the backyard. Besides, average age at first egg (20-21 wk), egg production 32 week (80%), egg production up to 72 weeks (200-220), average egg weight (56-58 g) and mortality in laying period (10 %) are the important features of Gramapriya laying hens. Housing can be provided as night shelter with locally available cheap materials like unused wire mesh, fish nets, bamboo, tarpolene sheets and coconut leaves. Feeding can be done with house hold food wastes, vegetable waste, kitchen waste, insect pests, green grasses and fallen grains available in the backyard.



Brooding of Gramapriya chicks

Gramapriya in the backyard

Management and health cover

Gramapriya chicks have to be brooded during the initial stages of their life i.e. 0-6 weeks of age. After 6 weeks they can be let free for scavenging in the backyard. Debeaking is essential at the age of 4-5 weeks in order to avoid cannibalism. The males of Gramapriya can be reared separately and marketed for meat purpose. The birds need to be habituated to return to the nest in the evening for night shelter. Night shelter should have good ventilation and should give protection for predators. Availability of plenty of clean and fresh water should be made throughout the life and birds must be vaccinated against Marek's and Ranikhet diseases. Since birds are reared in the backyard they are more prone to parasitic infestation. Therefore, periodic deworming at 3-4 month intervals is essential. For this purpose albendazole oral suspension (Albomar) can be given @ 3-5 ml/10 birds. White diarrhoea can be treated by giving Tetracycline

Night shelter for Gramapriya

Gramapriya in farmers backyard

powder in drinking water @ 1g/litre for 3-5 days. These birds can be reared under semi-intensive system by housing the bird in a litter floor house, and letting loose for free range scavenging in open backyard. The following vaccination schedule can be adopted for protection from prevalent diseases and keep the birds healthy for better production.

Cost involved and benefit envisaged

With an investment of Rs 190/ per bird, net income was found to be Rs 490/- per bird.

Source of the variety

ICAR Research Complex for Goa, Old Goa, Project Directorate on Poultry, Hyderabad, Andhrapradesh.

Vaccinations Schedule

Age (days)	Name of the vaccine	Dosage	Route of administration
1	Marek's Disease	0.20 ml	Subcutaneous
7	Ranikhet Disease (Lasota)	one drop	Eye drop
18	Ranikhet disease (Lasota)	one drop	Eye drop
28	Ranikhet Disease (R2B)	0.50 ml	Subcutaneous or IM
42	Fowl Pox	0.20 ml	Intramuscular (I/M)

4.14 Quail *(Coturnix coturnix japonica)* production and management technology

Dr. B. K. Swain
Email: rbkswain@yahoo.com

Introduction

Quail is also popularly known as "Bater". They are hardy and easy to handle, and adopt easily to diversified agro-climatic environments. With increasing cost of production and competition among broiler and layer farmers, some alternative and equally competitive farming has become very essential for the survival of the farmers. Further, the demand for fast food has increased tremendously. In this situation, quail farming proves to be an ideal venture for the poultry farmers who desire to increase their profit through diversification.The following unique characteristics of Japanese quails make them very important over farming of other poultry species. Japanese quail weighs 8-9g from hatching egg weight of 10-11g. Average body weight at 5-6 weeks is 180-200g and adult body weight is 200-250g. Females are heavier than males. The female is characterized by long and pointed feathers with black speckles on the throat and upper breast. The males have rusty brown throat and breast feathers. Sexually active males also have a cloacal gland, a bulbuous structure located at the upper edge of the vent which discharges a white foamy material. Very fast multiplier because of short generation interval and completes 3-4 generation per year. Prolific layer: lays 280-300 eggs per year. Early sexual maturity:6-7 weeks. Minimum floor space requirement i.e. 8-10 quails can be housed in a space required to house one broiler/layer chick. Low feed requirement: 30-35g per quail/ day. Early marketing age for table delicacy:5-6 weeks. High nutritive value of egg and meat. Quail eggs are low in cholesterol content than chicken egg. Quail meat is low in fat and cholesterol content and is an ideal food for infants, children, adults, old people and those attempting to control their weights.

Technology

Brooding and Management

Quails can be reared either in cages or on floors or a combination of both. Thus, the options for rearing systems are option I. Brooding (0-3 weeks), rearing (4-8 weeks) and laying (8 weeks onwards) in deep litter, option II. Brooding, rearing and laying in cages and option III. Brooding in battery brooder and both rearing and laying in deep litter. Quail chicks are brooded under 24 hr light upto 2-3 weeks of age which may be reduced to 12 hr by the end of 3 weeks and thereafter 12 hr photoperiod is adequate up to 5 weeks of age. About 14-16 hr photoperiod is recommended for laying quails.

Battery brooding upto 3 weeks of age appears to be better than floor brooding due to the small size of the chick. The floor should be preferably covered with corrugated paper so as to provide better foothold since high mortality occurs initially due to spraddled legs. The feeder and water space requirement during this period are 2-3 cm and 1-1.5 cm, respectively . Floor, feeder and water spaces should be increased with advance in age. Males and females should be reared separately. Females should be housed in laying cages at about 6 weeks of age. Continuous light should be provided for the first 48 hours. This can continue if birds are to mature earlier. Otherwise 12 hr light and 12 hr darkness may be followed during the growing period. Quail broilers are marketed at about 5-6 weeks of age. Eight hrs of light and 16 hrs of darkness at least 7-10 days before marketing may help to improve the condition of quail broilers.

Housing

Quails can be housed either on floor or in cages. The quail house should be open type, well ventilated and well covered with wire mash on the outside wall to prevent entry of predators like snake, mongoose, cat, etc. There should be provision of light and floor should be covered with litter material. Quails can be reared in multideck/ singledeck cages. The size of cage should be 120 cm length , 60 cm width

Brooding of Quail chicks

Adult Quails in Cages

Quail Chicks reared in cages

Adult Quails reared on deep liter

and 25 cm height with provision of faecal trays. For commercial purpose 20-30 quails can be reared in this cage. It is found that cage rearing of quails give better performance in terms of growth and egg out put because of less flight and less energy expenditure on other vices.

Feeding and management

For feeding quails efficiently and economically they can be classified as starter (0-3 weeks), grower (4-6weeks) and layer or breeder (7 weeks onwards) depending on their growth rate, efficiency of feed utilization and production and reproduction performance. The starter period is the most crucial period and needs special management and feeding care.

The young actively growing bird makes a larger gain in live weight per unit feed consumed. Therefore, feeding of quail to the age of 3 weeks is of special importance in as much as balanced and higher nutrient level required in diet. The nutritional requirement and practical rations of quails are presented in following Tables.

Practical levels of nutrient s (%) in the diet of Japanese quails

Nutrients	Starter (0-3 weeks)	Grower 4-6 weeks	Layer/Breeder (7th week onwards)
ME (Kcal/kg)	2,750	2,750	2,650
Protein (%)	25-27	22-24	20-22
Calcium (%)	1.0	0.8	3.0
Phosphorous, available (%)	0.45	0.45	0.45

Suggested practical rations for Japanese Quails

Ingredients (kg/100 kg)	Starter (0-3 weeks)		Grower (4-6 weeks)		Layer/Breeder (Beyond 6 weeks)	
	I	II	I	II	I	II
Ground Maize	50.00	45.00	48.00	45.60	50.00	45.00
Groundnut cake or soybean meal	32.00	32.00	30.00	30.00	30.00	30.00
Fish meal	12.00	12.00	10.00	10.00	10.00	10.00
Wheatbran	4.40	4.40	10.28	10.18	3.25	3.25
Ricekani	-	5.00	-	2.40	-	-
Cashew apple waste	-	-	-	-	-	5.00
DCP	0.56	0.56	0.89	0.94	1.14	1.14
Limestone	-	-	-	-	4.92	4.92
Common salt	0.40	0.40	0.40	0.40	0.40	0.40
Lysine	0.24	0.24	0.14	0.19	-	-
Methionine	0.10	0.10	-	-	-	-
Vitamin & Min. Mix.	0.30	0.30	0.29	0.29	0.29	0.29

Average feed consumptions per bird per day is 1st week -4 g, 2nd week -9g,3rd week -15g, 4th week -18 g, 5th week -20-25 g, 6th week onwards- 30-35 g.

Health cover

Quails may be debeaked at an age of 3-4 weeks or whenever required to control cannibalism. Quails are very sensitive to abrupt environmental changes, particularly during the first 2 weeks of their life. They need better care during the brooding age. Amprolium @ 1.25 g/ kg feed for 3 days for treatment or half of this quantity from day old to 2 weeks of age for prevention has been found to be effective to control coccidiosis in quails when they are reared on deep litter. Streptomycin or Tetracycline hydrochloride powder @ 1g/litre of drinking water can be used for 3 days to control ulcerative enteritis in quails. The hygiene and sanitation are of prime importance to eliminate or minimize the occurrence of diseases in quails. *Aspergillus fumigatus* causes brooder pneumonia in quails. This can be checked by adding calcium propionate @ 2 kg/tonne of feed, since it prevents the growth of fungus.

Cost involved and benefit envisaged

Cost involved in keeping 100 nos of Japanese broiler quail chicks for 5 weeks is Rs2000/- approximately. Keeping 10 % mortality in view 90 quails can be sold in Rs4500/-. The benefit envisaged is Rs2500/-.Cost involved in keeping 100 Nos. Of Japanese quail layers will be Rs23, 400/- for 1 year. The total income will be approximatelyRs43,300/- with net profit of Rs 20,000 per year.

Source of the variety

ICAR Research Complex for Goa, Old Goa, Central Poultry Development Organisation, Aeray Milk Colony, Goregaon, Mumbai, TANUVAS, Chennai, CARI, Izatnagar, U.P.

4.15 Formulation of low cost feed for poultry using locally available unconventional feed ingredients

Dr. B. K. Swain
Email: rbkswain@yahoo.com

Introduction

The convential feed ingredients like maize, soybean meal and rice bran are becoming expensive because of high demand and increasing competition with the human beings for the same items. Hence the search for alternative feed sources has become inevitable to reduce the feed cost. The agro-industrial by-products like brewery waste, cashew apple waste, cashew nut shell and rice kani (broken rice) are available in plenty locally. Presently these by-products are not exploited to full extent for inclusion in the poultry feed. Keeping their chemical composition and potential feeding value in consideration, these by-products can be incorporated to some level in the poultry feed formulations to economise the feed cost and to increase the profit margin for the poultry farmers.

These feed ingredients can be incorprated in the feed of backyard poultry chicks, growers, layers commercial broilers and layers and Japanese quail chicks , growers and layers by replacing the costly feed ingredients to some extent in the feed formulation to reduce the feed cost and cost of production.

Technology

Proximate composition of unconventional feed ingredients

Chemical Constituents	Composition (%)			
	Brewers' dried grain	Cashew apple waste	Cashew nut shell	Rice Kani (Broken rice)
Dry matter	90.10-93.00	18.40-22.50	-	87.90-95.50
Crude protein	15.50-30.89	6.45-11.40	5.00	7.19-8.70
Ether extract	7.00-11.05	3.35-11.04	11.7	1.4-1.5
Crude fibre	9.55-20.00	8.50-11.85	27.3	0.7-1.2
Total ash	3.09-11.04	3.51-6.15	1.39	0.3-3.30

Brewers' dried grains

Ground Brewers' dried grains

Practical diets for Vanaraja growing chick and quail chicks and layers with inclusion of broken rice

Ingredients	Vanaraja growing chick	Quail Chicks	Quail layers
Maize powder	35.00	40.00	40.80
Groundnut cake/ Soybean meal	23.00	32.00	36.00
Fish meal	10.00	10.00	-
Wheat bran/ rice bran	15.00	4.06	6.67
Rice kani (Broken rice)	15.00	10.00	7.20
DCP	1.00	0.90	1.78
Limestone	-	-	6.66
L-Lysine HCl	0.14	0.03	0.01
DL-Methionine	0.01	0.01	0.09
Common salt	0.40	0.40	0.50
Mineral mixture	0.25	0.25	0.25
Vitamin mixture	0.04	0.04	0.04

Practical diets for Vanaraja growing chickens and Japanese quail chicks using cashew apple waste (CAW)

Feed ingredients	Composition %	
	Vanaraja growing chicks	Japanese quail chicks
Maize	40.00	45.00
Groundnut cake/ Soyabean meal	22.00	36.00
Fish meal	10.00	10.00
Wheat bran/ rice bran	17.74	1.85
CAW	8.00	4.50
Di-calcium Phosphate	1.00	1.40
L-Lysine HCl	0.16	0.35
DL-Methionine	0.20	-
Common salt	0.40	0.40
Vitamin and Mineral mixture	0.50	0.50

Fresh Cashew apple

Dried Cashew Apple waste

Practical diet for Broilers, Vanaraja chicks and Japanese quail layers with inclusion of brewers' dried grain (BDG)

Ingredients	Diet (Broilers)	Vanaraja chicks	Japanese quail layers
Yellow ground maize	55.00	48.00	49.00
Soybean meal	30.00	23.00	27.00
De-oiled rice bran	7.1	21.00	9.20
BDG	5.00	5.00	5.00
Di-calcium Phosphate	1.02	1.06	1.47
Limestone powder	-	1.38	7.56
Common salt	0.50	0.50	0.50
L-Lysine HCl	0.36	-	-
DL-Methionine	0.14	0.05	0.03
Vitamin Mixture	0.04	0.02	0.02
Mineral Mixture	0.15	0.15	0.15

Economics

Feed cost for production of 1 kg live weight of broilers is Rs 30/- with a net profit of Rs15/broiler when BDG is included at a level of 5 % in the diet. Use of 8 % cashew apple waste by replacing 20 % maize in the diet of vanaraja chicks up to 8 weeks of age incurred expenditure of Rs 29.6/- per kg body weight gain with a saving of Rs1.5/- over the control group quails.

Source

ICAR Research Complex for Goa

Fishery Science

5.1 Rice-fish integrated farming system

Dr. S. Subramanian
Email: subra550@yahoo.com

Introduction

In the standing water of a low lying rice fields, there is always natural fauna of plankton, insects, mollusks and larvae, which serve as food of carps. This food material which otherwise goes waste can be recycled through a combination of fast growing carps species. Presently, in about 40,000 ha of low lying rice fields of Goa, rice cultivation is made without fish culture. Low-lying rice fields where 10-20 cm of water column could be maintained and regulated for a period of 6 months or more are suitable for rice-fish combination. In field where two crops of rice which cultivated in a year, it could be easy to integrate culture of freshwater fish as well. In addition to the two crops of rice and fish, it would also be possible to have a third summer crop, if irrigation is available.

Technology

To make the rice fish functional, the field should be bunded and a pond of 1/10 of size of the field should be provided in the field to facilitate the stocking of fish during rice transplanting, harvest and non-rainy period. A minimum of 1000 m^2 field area separated by bunds, is preferable. Water should be managed at the 50 percent level of the rice plant.

Fish species

Pre-reared advanced fingerlings of carps such as Catla, Rohu, Mrigal and Common carp of 10-15 cm size (100-150 g) are to be stocked before the onset of monsoon at the stocking density of 1500-2000 fingerling /ha (150-200/1000 m^2 of field) at the ratio of 2:2:1:1, respectively.

Rice variety

Medium to long duration and medium to tall in height rice varieties which are less susceptible to water lodging, pests and diseases, are suitable for cultivation. While the first crop of rice may be necessarily transplanted. Jyoti and Vyttila rice varieties are suitable for both kharif and rabi in Goa. For the third crop, cowpea, vegetables, groundnut or water melon could be grown under irrigation. If the bunds are broad enough, fodder grass, banana, vegetables, pineapple and coconut can be cultivated.

Harvest

During harvest of first crop and transplanting of the second crop, water has to be drained from the field allowing the fishes to move to the pond. However, the second crop can be harvested without draining the water so that a column of water is retained in the field for longer duration when

there is no water replenishment by rain.

The fish could be harvested after the second crop when water level goes down. Harvest of fish could also be done after draining water from the field so that fish could be collected from the pond.

Rice and fish yield

Vyttila-1 has the desired height and yield, suitable for the water-logged condition. It was observed to grow over one meter height and 3.0 tonnes/ha during khariff and 6.0 tonne / ha in rabi. A fish production rate of 1,250 kg/ha /8 months was recorded with an average individual growth of one kg when stocked with advanced carp fingerlings at 1,500-2,000/ ha stocking density and without supplementary feeding and pond fertilization.

Economics

Economics of the system calculated based on the results of fields trials conducted at Goa and Kerala and projected for a 0.1 ha field with a 0.01 ha pond inside for a combination of four species of carps, two rice crops and groundnut crop on residual moisture and Sesamum, water melon or vegetables as summer crop, depending on water availability gave a net profit of Rs. 12,200/- for an expenditure of Rs.13, 500/-

Source

ICAR Research Complex for Goa

5.2 Poultry- Fish integrated farming system

Dr. S. Subramanian
Email: subra550@yahoo.com

Introduction

Utilization of small water bodies for carp culture and integrating with poultry rearing by recycling the bird dropping through fish pond would be revenue generating and enterprising By integrating poultry with fish, the expenditure on pond fertilization and fish feeding can be avoided, as the droppings of the birds are good souce of nutrients for the production of natural fish food in the pond. In regular fish culture, the pond is manured and fertilized for the production of the fish food organism called 'Plankton' and in addition, the fishes are also fed with supplementary feed to enhance production. Poultry is reared normally as a backyard enterprise in Goa. Carps are cultured in small homestead ponds and integration of the two has not been practiced. The poultry-fish integrated farming can be employed in both freshwater bodies, homestead ponds and irrigation structures and also tried in brackishwater ponds to reduce input, effective utilization of available water bodies and increase farm income.

Technology

Pond is prepared, a poultry shelter is constructed on the pond bund and advanced fingerlings of carps of species Catla, Rohu, Mrigal and Common carp stocked in the ratio of 2:2:1:1 at the stocking density of about 6,000/ ha. Layer birds of breed like Astrawhite, are reared for 10 to 12 months. Six week old chicks were stocked intially which started laying eggs after 20th week. A bird void about 100 g per day. With 40 to 50 birds / 0.1 ha, about 4 to 5 kg of droppings are recycled daily through fish pond by the production of sufficient plankton. The poultry husbandry practices are followed and input on pond fertilization and fish feeding are avoided. Harvest of

fish from pond can be made either when the fish attain the marketable size of 1 kg average or after one year of culture or when the water level in the pond is reduced less than a metre. Over 3,500 kg to 4,200 kg of fish could be harvested per ha for 3-4 species combination, under the system. The healthy birds lays about 250-280 eggs per year.

Economics

For a 0.2 ha pond with a about 60 birds a net profit of about Rs.78,000/- can be obtained with an expenditure of Rs. 68,000/-

Source

ICAR Research Complex for Goa

5.3 Duck-Fish integrated farming system

Dr. S. Subramanian
Email: subra550@yahoo.com

Introduction

Carp culture is a recent introduction which is being taken up by farmers in their homestead ponds and small freshwater bodies including irrigation structures. Though duck rearing is not very popular in Goa, their meat and eggs are delicacy and can give good returns. For regular fish culture, the ponds are manured for production of fish food called 'Plankton' and in addition, feeding of fish should also be done to enhance production. Fish culture and poultry rearing are practiced separately. By utilizing small water bodies and ponds for fish culture and integrating with duck culture will help reducing the input cost for pond fertilization and fish feeding, as the duck droppings will produce enough plankton for feeding the fish. Ducks also get about 30 percent of their food from the pond as they feed on aquatic weeds, insects, mollueses etc., which do not form the food of fish.

Technology

Pond is prepared and advanced fingerlings of the fast growing varieties of carps namely Catla, Rohu, mrigal and common carp are stocked at the ratio of 2:2:1:1 in the stoking density about 6,000/ha. A duck night shelter can be constructed on the pond bund or a floating cage can be fabricated for housing the ducks. Dual type White Pekin birds are suitable for the combination. Thirty ducklings of 6 weeks age @ 30 per 0.1 ha pond would be sufficient to fertilize the pond. Initially the ducklings have to be trained to come back into the night shelter after foraging during day time. One duck would void about 150 droppings per day. After about six months a duck starts laying eggs and 200-300 eggs per year. Instead of the floating cage, night shelter for ducks can also be built on the pond bund.

Economics

From a 0.2 ha pond, the duck fish integration would give about Rs.68, 000/- net profit for an expenditure of Rs. 53,000/- with a gross return of Rs.1, 21,000/-.

Source

ICAR Research Complex for Goa.

5.4 Mussel farming in brackishwater areas

Dr K. N. Mohanta and Dr. S. Subramanian
Email: subra550@yahoo.com

Introduction

Mussel farming is an alternative candidate species for diversification of aquaculture in brackishwater areas. In nature, usually mussels are found in the inter-tidal zone where for every six hours they are submerged in water when they open their shell and feed. During alternate six hours when there is low tide, they close their shell. Grown up mussels of marketable size of more than 3.0 inches are hand picked during low tide as a subsistence fishery during month from February to May. Green mussels is naturally distributed in rocky substratum of the intertidal zone in many parts of the coast of Goa like Baga and Donapaula. It is also available in the brackishwater creeks and bays where there is rocky substratum. The seeds called spats can be collected from the natural environment in many part of coastal Goa, Karnataka and Maharashtra.

Technology

Species: *Perna viridis* (Green mussel)

Mussels are cultured in raft and long line systems. A rectangular raft is made by bamboo poles with floats, from which ropes containing the young ones of mussel are suspended in water. Where ever depth of water is less, the long line method is adopted. The culture of mussel is to be started in the month of October-November and the harvest can be done in the month of April-May before the onset of monsoon, giving a total culture period of about five months to get a marketable size.

Suitable areas

The mussel culture can be made in the open sea, protected base, all along the estuarine backwater where there are culture ponds.

Performance

The growth of the mussel in natural environment would be from an average initial total length of 2 cm to 7 cm within 4 months and upto 10 cm. In culture system, mussels continuously feed on naturally available food materials in the water; thereby the culture period to marketable size of mussel is cut short to about 5–6 months. The harvested mussel may be depurated for better hygiene and sanitary purposes before sale.

Economics

The calculated economics of culture indicated a net profit of ₹ 20,000/- for the first year and ₹ 30,000/- during the second and third years, for a unit raft size of 5m x 5m. One unit can hold about 100 strings, each of which can be seeded with 400 numbers. With an average of 300 numbers growing out to 30 to 40 g size in five months, a total of about1, 000 kg of mussel can be harvested from a single unit. The initial cost of establishment of the raft and the cost of seed could be ₹ 20,000-25,000/unit. The same bamboos and the ropes can be used for the second and third years thereby saving about ₹ 10,000/year. The sale price of each mussel is ₹. 2/- a piece or even higher, depending upon the local demand. The sale price from single unit will be ₹ 50,000 to 60,000/-

Source

ICAR Research Complex for Goa.

5.5 Remote sensing based potential fishing zone forecasting for marine fisheries

Dr. S. Subramanian
Email: subra550@yahoo.com

Introduction

The marine capture fisheries depends upon various factors such as fish stock, nutrition status, food availability, weather parameters, monsoon, wind, upwelling, dynamics of the ocean, craft and gear fishing intensity and the traditional knowledge of fishermen**.** With advent of mechanization, the fisherman has to search in the open sea spending valuable fuel and time, which make the fishing operation uneconomical. As a result the mechanized vessels tend to fishing near shore areas competing with a traditional and shore operated gears.

Potential Fishing Zone forecast

Based on the satellite imaginary and oceanic parameters like sea surface temperature (SST), Chorophyll and wind direction it is possible to forecast potential fishing zones where fish may be available. INCOIS, Hyderabad, disseminates PFZ advisories thrice a week on non cloudy days which are retransmitted by the Institute to the fisherman through FAX, e-mail and recently Electronic Display Board installed (EDB) at important landing centres along Goa coast for the benefit of fishermen, free of cost. The forecast includes a map and data indicating depth, distance and angle from landing centre, at which the PFZ is located.

Experiement results

Data collected through feedbacks on fish catch landing and experiment on fish catch from PFZ and Non-PFZ areas indicated that the technology is useful mostly for pelagic gear operators, especially purse seines.

Performance

Normally by using this technology fisherman obtaining the catch of Mackerel, Oil sardine, Seer fish, Tuna, Horse mackerel, etc., which yield around 2-5 tonnes catch compared to less than 2.0 tonnes of fish without using the PFZ advisory. Many a time the fishermen come back without fish if they are not using PFZ.

Benefits

It has been observed that through the application of PFZ technology, the fishermen particularly the purse seine operators could reduce the fuel consumption, fish search time and human drudgery to an extent of 30-70 percent. With the PFZ advisory, the mechanized vessels are venturing deeper waters of depth higher than 50 meters, leaving the near shore waters for the benefit of traditional fishermen.

5.6 Freshwater ornamental fish seed production

Dr. S. Subramanian and Dr. K. N. Mohanta
Email: subra550@yahoo.com

Introduction

Aquarium fish keeping is becoming increasingly popular hobby in households and tourism industry, creating a demand for production of ornamental fish seed of popular varieties. Ornamental fish trade is becoming one of the highest revenue generating ventures both for local and export markets. The most popular varieties of ornamental fishes are the freshwater ones. There are two type of freshwater ornamental fishes namely egg layers and live bearers. Gold fish, Golden carp, Koi, Angel, Guorami, Barbs, Cat fish, Sucker fish and loach are some of the popular varieties of egg layers and Guppy, Molly, etc., are popular live bearers. There are many varieties and colour variations within each species of ornamental fishes. Seed production is an important area which includes, brood stock raising, breeding, nursery, rearing to saleable size, production of live feeds and formulated feeds for raising these seeds. Goa has a good potential for small scale production of many of these ornamental fishes considering the local demand and tourism influx, which can be a very good livelihood opportunity. Majority of popular varieties are now imported from other countries and resold in India. Besides, there are indigenous species which can be promoted as ornamental fishes. Each species breeding and feeding nature is distinctly different and the seed production is dominantly the monopoly of private sector.

Technology

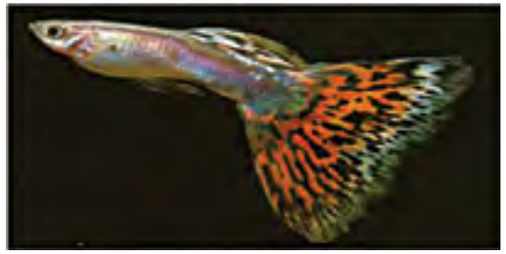
Breeding technology for the following varieties of freshwater ornamental fishes have been refined including its nursery raising, production of green water, Moina, and spirulina as live feeds for feeding different stages of the fish and formulation of nutritional and economical feeds based on the nutritional requirement. Gold fish including Shubunkin, lion head, black moor, Veil tail, Oranda, Gold carps including Koi, Gourami, Angel, Sword tail, Guppy, black and white Molly.

The requirement of ornamental fish seed formulations are outdoor and indoor tanks, breeding tanks, glass aquaria, water circulation and aeration facilities, live feed and formulated feed preparation facilities, nets, medicines, etc., Training on breeding and different aspects of seed raising is essential. As this is taken up as a cottage industry, economics has to be worked out on a case to case basis depending upon the species, capacity and volume required.

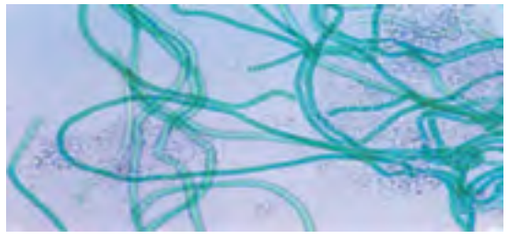
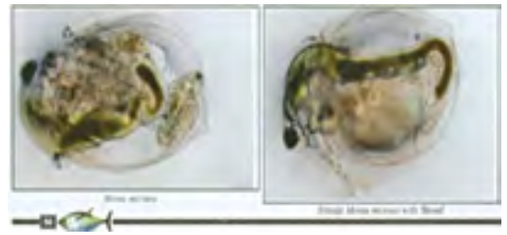
Source

ICAR Research Complex for Goa.








List of Contributors

Dr. H. M. Wasnik

Dr. S. Manivannan

Dr. S P. Singh

Dr. B. L. Manjunath

Dr. R. R. Verma

Dr. K. K. Manohara

Dr. J. R. Faleiro

Dr. R. Ramesh

Dr. A. R. Desai

Dr. N. P. Singh

Dr. R. Desai

Dr. P A Mathew

Dr. S. Priya Devi

Dr. M. Thangam

Dr. K. Ramachandrudu

Dr. S. A. Safeena

Dr. S. B. Barbuddhe

Dr. E. B. Chakurkar

Dr. S. K. Das

Dr. Prafulla Kumar Naik

Dr. B. K. Swain

Dr. S. Subramanian

Dr K. N. Mohanta

भाकृअनुप
ICAR

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Agrisearch with a human touch