# PRACTICAL MANUAL

ON

# **Agroforestry Systems and Management**

FSA 402 3(2+1)

For B.Sc. Forestry VIII Semester students



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2020

# RANI LAKSHMI BAI CENTRAL AGRICULTURAL UNIVERSITY, JHANSI

#### Agroforestry Systems and Management FSA 402 3(2+1)

Name of Students

**Practical:** Study the desirable characteristics of trees/shrubs/grasses for various agroforestry programmes. Assessment of standing stock of tree species in various agroforestry systems such as homegardens. Survey of agroforestry practices in local/adjoining areas. Field observations to characterize the structural, functional and economic attributes of the following agroforestry systems and practices- agro-silvi-culture systems, silvo-pastoral systems, pastoral silviculture systems, agro-silvo-pastoral systems, shelterbelts and windbreaks, live fences; fodder trees and protein banks. Exercise on Diagnosis and Design of agroforestry systems and practices. Assessment of productivity of tree crop combinations. Studying resource partitioning in agroforestry systems - water, light and nutrients. Analysis of soil and plant samples for organic carbon N, P and K.

Roll No.		
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Session		
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Course Name :		
Course No. :	Credit	
Published: 2020		
No. of copies:		
Price: Rs.		
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completed the practical of course		course No.
as per the syllabus of B.Sc. (Hons.) Ag	griculture/ Horticulture/ Forestry	semester in
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18.	Analysis of phosphorus (P) for given plant / soil samples		
19.	Analysis of potassium (K) for given plant / soil samples		

# Objective: To Study the desirable characteristics of trees/shrubs/grasses for various agroforestry programmes

- Agroforestry systems exhibit a great intricacy with respect to their components where trees, shrubs, climbers and grasses are common
- Trees and shrubs play a vital role in maintaining an ecological balance and improving the livelihood of people. If this role is to be developed and expanded, the function and place of trees and shrubs in the rural landscape must be analyzed and understood.
- Trees in addition to providing fodder, fuel, wood, and other products, trees in agroforestry systems
  promote soil and water conservation, enhance soil fertility, and act as windbreaks for nearby crops.
- Shrubs have been meeting the fuel wood requirement of the local peasants from forest as well as village wasteland and field boundaries.
- Grasses as a component of a farm system, the properly designed and implemented agroforestry practice will help for performing beneficial impacts.
- In agroforestry land use systems the woody perennial components ('trees') along with grasses play
  a role in both productivity and sustainability. Some general characteristics of woody perennials are
  need to be outline and the consider the advantages and disadvantages of these in relation to
  specific agroforestry systems is emphasized.

Exercise: Desi	rable characteri	stics of trees for	r various agrofo	prestry programm	nes:
	• • • • • • • • • • • • • • • • • • • •				

Desirable characteristics of shrubs for various agroforestry programmes:
Desirable characteristics of grasses for various agroforestry programmes:

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# Objective: Assessment of standing stock of tree species in various agroforestry systems-Homegardens

- Homegardens agroforestry system is one of the most prevalent types of land use systems suitable to high rainfall areas in tropical conditions.
- Homegardens represent intimate, multistory combinations of various perennial and annual crops, sometimes in association with domestic animals, around the homestead which serves as a permanent or temporary.
- Traditional resource management adaptations such as homegardens in agroforestry systems may
  potentially provide options for improvement in livelihoods through simultaneous food production
  (either directly food grains, fruits, vegetables and root crops or indirectly improving soil conditions
  and there by promoting understory crop productivity especially on degraded sites), fodder and
  firewood, high biodiversity, low use of external inputs, soil conservation potential, nutritional
  security, ecological benefits, socio-cultural as well as mitigation of the impact of climate change.
- By providing supportive and complementary roles with a flexible approach, homegardens offers specific social and environmental benefits across a range of landscapes and economies.
- Assessment of standing stock of tree species in homegarden having a huge importance in terms of biomass calculation and estimation of carbon

1. Name of visiting homegarden:

2. Location:

3. Area: .....

#### Field Exercise:

Locality:			
Area (m²):			
Presence of tree species in	n homegarden:		
Tree	e Species	No.	Uses
Common Name	Scientific Name		
	Area (m²):  Presence of tree species i  Tre	Area (m²):  Presence of tree species in homegarden:  Tree Species	Tree Species No.

10.					
11.					
12.					
13.					
14.					
15.					
7.	Sampling procedure	& Methodolo	av		
	Camping processing		<b>3</b> 3 · · · · · · · · · · · · · · · · · ·		
0					
ŏ.	Estimation of standing				
	Above ground bioma	ıss (t/na):			
	<b>D</b> 1 111	// II \			
	Below ground bioma				
	Total biomass (t/ha):			 	
	Total biomass (t/ha): Carbon Stock (t/ha):			 	
9.	Total biomass (t/ha):			 	
9.	Total biomass (t/ha): Carbon Stock (t/ha):			 	
<b>9.</b>	Total biomass (t/ha): Carbon Stock (t/ha):			 	
9.	Total biomass (t/ha): Carbon Stock (t/ha):				
9.	Total biomass (t/ha): Carbon Stock (t/ha):				
9.	Total biomass (t/ha): Carbon Stock (t/ha):				
9.	Total biomass (t/ha): Carbon Stock (t/ha):				
9.	Total biomass (t/ha): Carbon Stock (t/ha):				
9.	Total biomass (t/ha): Carbon Stock (t/ha):				

#### Objective: To conduct survey of agroforestry practices in local/ adjoining areas

- Agroforestry is unique in many respects, both as a science and as a practice. One such aspect is its inseparable mixture of biophysical principles and social objectives.
- Agroforestry is the management and integration of trees, crops and/or livestock on the same plot of land and can be an integral component of productive agriculture. It may include existing native forests and forests established by landholders. It is a flexible concept, involving both small and large-sized land holdings.
- In agroforestry, the ecological function of trees, crops, and animals can increase food production while at the same time reducing the impact of agriculture on the environment.
- In other words, the rural poor are commonly considered as the primary beneficiaries of agroforestry; consequently, agroforestry technologies are expected to be especially relevant and applicable to small-scale land-users with low capital- and energy-requirements, and to yield products and benefits directed to immediate human needs rather than commercial advantages.

#### Field Exercise:

1.	Name of the visiting agroforestry sites:	
2.	Date of visit:	Day:
3.	Locality:	
5.	Geographical location:	
3.	Altitude:	
3.	Presence of agroforestry tree species in the	e sites

#### 8

S.	Tree Species	No.	Uses		ance	Other Information	
No	Common Name	Scientific Name				Plants	
					(m²)	(m²)	
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							
13.							

Cri	teria for selection of	tree species:		
lde	entification of agrofo	restry systems (On th	ne basis of structure an	nd function):
S.	Name of		Components	
No.	agroforestry system	Trees	Crops	Pasture
١.	Agri-silvi			
2.	Silvi-pasture			
3.	Agri-silvi-pasture			
l.	Others			
۸۵	roforestry practices	and their importance	<u> </u>	<b> </b>
S.		Importance	••	
No	. agroforestry	importance		
1.	Practices			
2.				
3.				
4.				
4. 5.				
6.				

12.	Diagrammatic representation:
ا .13	Benefits of agroforestry practices to socieo-economic status of the family:
14.	Suggestion:
15.	Conclusion:

.....

#### Exercise No. 4

# Objective: Field observations to characterize the structural, functional and economic attributes of the agri-silviculture system

- Agri-silviculture is a production technique which combines the growing of agricultural crops with simultaneously raised and protected forest crops. This practice, called agri-forestry, has been in existence in various primitive forms since man learned to clear forests and cultivate land, and has different names in different parts of the world.
- In various ways agri-silviculture seeks to create harmony between crop farming and tree farming.
  Decidedly, the system is not an easy one and at times the plans may not fully materialize. indeed,
  those patient, flexible and intelligent administrators who understand and sympathize with the forest
  farmers, their traditions and their human needs are among the most important elements of success
  of any system of agri-silviculture.

#### Advantages:

- Produce multiple products such as food/vegetables/fruits, fodder and forage needed for livestock, fuel wood, timber, and leaf litter needed for organic manure production.
- Improve and sustain the crop productivity which increases the level of income of the farmers.
- Improve the nutritive value of animal feed due to the supply of green fodder.
- This is also the best practice for soil nutrient recycling, which also helps to reduce chemical fertilizer purchase.
- Improve the farm site ecology by reducing surface run off, soil erosion and nutrient loss, gully formation and landslides.
- Improve the local micro-climate and enhance the productive capacity of the farm.
- Reduce pressure of community forests and other natural forests for fodder, fuel wood and timber.
- This practices helps for the beautification of the surrounding areas

#### Field Exercise:

1.	Name of the visiting agri-silviculture system sites:	
	Date of visit: Day:	
3.	Locality:	
4.	Area (m²):	
	Geographical location:	
6.	Altitude:	
7.	Slope:	
	Presence of tree and cron species in agri-silviculture system	

# 3. Presence of tree and crop species in agri-silviculture system

S.	Tree Species		No.	Uses	Distance		Crop Component	
No	Common Name	Scientific Name			Rows (m²)	Plants (m²)	Common Name	Scientific Name
1.								
2.								
3.								

	6.										
	7.										
	8.										
•	9.										
	10.										
9.	Cr	iteria for s	select	ion of	tree a	nd cro	p spe	cies:	 	 	 
							· ·		 	 	 
	••••								 	 	 
10	. Fu	ınction of	visite	d agri	-silvic	ulture	syster	n	 	 	 

4. 5.

11.	Diagrammatic representation:
40	
12.	Net amount of money gains by adapting agri-silviculture system:
13.	Suggestions:
14.	Conclusion:

#### Exercise No. 5

# Objective: Field observations to characterize the structural, functional and economic attributes of the silvo-pastoral system

- Silvopastoral systems (SPS) are a type of agroforestry arrangements that allows the intensification of cattle production based on natural processes that are recognized as an integrated approach to sustainable land use.
- For agricultural based economies where population pressure is high there implementation of silvopastoral system adds value in conserving and utilizing land for maximum benefits.
- Silvopasture is important activity when it is economical to run a single species, cattle, under a
  monoculture in a large silvopastoral operation. On small farms, in the tropics diversification of
  animal and plant species is the most efficient utilization of the resource and provides a variety
  of products.

#### Advantages:

- Return on investment: By adding a livestock production component, silvopasture creates a stable source of cash flow prior to nut or timber harvest and diversifies the forestry enterprise. For livestock graziers, add a long-term timber while maintaining forage production provides more income than grazing alone.
- **Silvicultural benefits:** Nitrogen-fixing forage species, pasture fertilization and animal manure all help improve the soil and tree nutrition. Grazing controls competing brushy species and reduces fire hazard. Competition between trees is less at the wider spacings employed with silvopasture. The result is greater timber yield.
- **Livestock benefits:** Trees create a sheltered microclimate to protect animals from heat and cold. Shelter also improves forage quality and lengthens its growing season. The prunings of some trees can also be used as fodder, e.g. poplar. The result is better livestock growth.

#### Field Exercise:

1.	Name of the visiting silvo-pastoral system sites:
2.	Date of visit: Day:
3.	Locality:
4.	Area (m²):
5.	Geographical location:
6.	Altitude:
	Slope:
	Presence of tree and pastures in silvo-pastoral systems

S.	Tree Species		No.	Uses	Uses Distance		Pastures	
No	Common Name	Scientific Name			Rows (m²)	Plants (m²)	Common Name	Scientific Name
1.								
2.								

Ī									
ľ	4.								
ļ	5.								
•	ô.								
	7.								
	3.								
•	9.								
	10.								
9.	Cr	iteria for sele	ction of	tree spe	cies:		 	 	
10	 Fu	ınction of visi	ted silvo	-pastor	al system	s	 	 	
10	 Fu	ınction of visi	ted silvo	-pastora	al system	s	 	 	
10	 Fu	ınction of visi	ted silvo	-pastora	al system	s	 	 	
10	 Fu	inction of visi	ted silvo	-pastora	al system	s			
10	 Fu	inction of visi	ted silvo	-pastora	al system:	s	 	 	
10		inction of visi	ted silvo	-pastora	al system:	s	 		
10		inction of visi	ted silvo	-pastora	al system:	s	 		
10		inction of visi	ted silvo	-pastora	al system:	s	 		
10		inction of visi							
10									
10									
10									
10									
10									
10									

3.

11.	Diagrammatic representation:
12.	Net amount of money gains by adapting silvo-pastoral systems:
13.	Suggestions:
14.	Conclusion:

•••								Exercise N	
Obje		eld observation						functional	
The	e trees and	ombined with produstrubs may be use bod, and fruit or to in	d primarily to	produc			•		
		commodity involved s, ground legumes		•		•		•	n tha
oriç	gin subsequ	nent is largely contr lently is enhancing g, sustainability of l	the socieo-e	conomic					
Field	Exercise:								
1. N	ame of the	visiting silvo-past	oral system	n sites:					
2. D	ate of visit			Day:					
3. L	ocality:								
1. A	rea (m²):								
5. G	eographica	al location:							
6. A	ltitude:								
<i>,</i> , ,	itituaci								
7. S	lope:								
7. S	lope:	pastures and tree			ıstoral-		ure syster		
7. S 3. P	lope:resence of	pastures and tree	es species a	ınd in pa	storal-	silvicult	ure syster	n Pastures	ific
7. S 3. P S.	resence of	pastures and tree	es species a	ınd in pa	storal- Dist Rows	silvicult ance Plants	cure syster	n Pastures Scienti	ific
7. S B. P S. No	resence of	pastures and tree	es species a	ınd in pa	storal- Dist Rows	silvicult ance Plants	cure syster	n Pastures Scienti	ific
7. S B. P S. No	resence of	pastures and tree	es species a	ınd in pa	storal- Dist Rows	silvicult ance Plants	cure syster	n Pastures Scienti	ific
7. S B. P S. No 1.	resence of	pastures and tree	es species a	ınd in pa	storal- Dist Rows	silvicult ance Plants	cure syster	n Pastures Scienti	ific
7. S B. P S. No 1. 2.	resence of	pastures and tree	es species a	ınd in pa	storal- Dist Rows	silvicult ance Plants	cure syster	n Pastures Scienti	ific
7. S B. P S. No 1. 2. 3.	resence of	pastures and tree	es species a	ınd in pa	storal- Dist Rows	silvicult ance Plants	cure syster	n Pastures Scienti	ific
7. S 8. P S. No 1. 2. 3. 4.	resence of	pastures and tree	es species a	ınd in pa	storal- Dist Rows	silvicult ance Plants	cure syster	n Pastures Scienti	ific
7. S 3. P S. No 1. 2. 3. 4. 5.	resence of	pastures and tree	es species a	ınd in pa	storal- Dist Rows	silvicult ance Plants	cure syster	n Pastures Scienti	ific
7. S 3. P S. No 1. 2. 3. 4. 5. 6.	resence of	pastures and tree	es species a	ınd in pa	storal- Dist Rows	silvicult ance Plants	cure syster	n Pastures Scienti	ific

11.	Function of visited pastoral- silviculture system
11	Diagrammatic representation:
• • •	Diagrammatic representation.
12.	Net amount of money gains by adapting pastoral- silviculture system:
13.	Suggestions:
14.	Conclusion:


#### Exercise No. 7

# Objective: Field observations to characterize the structural, functional and economic attributes of the agri-silvi-pastoral system

- Agri-silvi-pastoral systems is a collective term for land-use systems, which combine a woody component (trees or shrubs) with cattle on the same site. These systems represent a model of production and conservation based on silvi-culture, the practice of growing trees, complementary to pre-existing agricultural activities.
- It is foremost in dry lands that forests and agri-silvi-pastoral systems play crucial economic, social
  and environmental roles. These include improved environmental sustainability and resilience of
  wider landscapes. These systems harbour species that are particularly well adapted to extreme
  ecological conditions and provide essential goods and environmental services.
- Agri-silvi-pastoral systems are of great importance for sustaining rural communities in drylands, especially low-income communities.

#### Field Exercise:

1.	1. Name of the visiting agri-silvi-pasto	ral sites:	
	2. Date of visit:		
	B. Locality:		
	1. Area (m²):		
	5. Geographical location:		
	6. Altitude:		
	7. Slope:		

#### 8. Presence of tree, crops and pastures in agri-silvi-pastoral system

S.	Tree Species		No.	Uses	s Distance		Crops	Pastures	
No	Common Scientific Name				Rows	Plants			
	Name				(m²)	(m²)			
1.									
2.									
3.									
4.									
5.									
6.									
7.									
8.									
9.									
10.									

9.	Criteria for selection of tree, crop and pasture species:
12.	Function of visited agri-silvi-pastoral system
11.	Diagrammatic representation:
12.	Net amount of money gains by adapting agri-silvi-pastoral system:
13.	Suggestions:

14		Conclus	sion:						
0	bje	ctive:		observations omic attributes o					
•	Windbreaks are rows of trees or shrubs that reduce the force of the wind. They can reduce soil erosion, increase crop yields and protect livestock from heat and cold. Windbreaks can shield buildings and roads from drifting snow. They beautify the landscape and provide travel routes and habitat for wildlife. Windbreaks can also be sources of wood and food.								
•	Shelterbelt is a wide belt of trees, shrubs and grasses, planted in rows which goes right across the land at right-angle to the direction of the prevailing winds to deflect air current, to reduce wind velocity and to give general protection to cultivated areas against wind erosion and desiccating effect of the hot winds in lee-ward side.								
A	dvai	ntages:							
• • • • • Fi	Mitigating the effects of pesticide spray drift Permitting better crop pollination by reducing wind speeds Reducing irrigation needs and assist with disease control Protecting crops from early frost damage by circulating air Reducing energy consumption and odour control around livestock barns								
1.	N	ame of t	he vis	iting shelterbelts ar	nd windbre	aks sites:			
2.									
3.	Lo	cality:							
5. 6. 7.	Area (m²):  Geographical location:  Altitude:  Slope:  Presence of multipurpose tree species in the sites								
	S.		7	Tree Species	No.	Uses	Dista	ance	Other Information
	No	Comr Nar	non	Scientific Name	9		Rows (m²)	Plants (m²)	
	1.	11441					\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	\ <i>)</i>	
	2.								
	3.								
	4.								

-									
	5.								
	<b>3</b> .								
1	7.								
	3.								
	).								
ļ									
	10.								
9.	C	riteria for sel	ection of tree	e species for s	shel	terbelts and wind	break:		
				··········					
	•								
	••								
13	F	unction of vis	sited shelterl	belts and wind	dbre	ak			
	••								
	••								
	••								
11.	. [	Diagrammatic	representat	ion:					
	Г								
	ı								
	ı								
	ı								
	ı								
	ı								
	ı								
	ı								
	L								
12	•	Net amount of	of money gai	ns by adaptin	g sr	ielterbelts and wi	ndbrea	ak:	
13		Suggestions							
	_								
	••								
	••								

14. C			
			Exercise No. 9
Objec		vations to characterize the stru tributes of the live fences	uctural, functional and
	ng fences are lines of t pounds, pastures, fields	rees or shrubs planted on farm boundaries or animal enclosures.	es or on the borders of home
• Thei	ir mean purpose is to co	ontrol the movement of animals or people.	
		ntiates them from other agroforestry technolantings, contour strips or hedgerow intercr	
		to control human and animal movement las windbreaks or enrich the soil, depending	· , ,
Field E	xercise:		
1. Nan	ne of the visiting live f	ence sites:	
2. Dat	e of visit:	Day:	
3. Loc	ality:		
	` ,		
	-		
·	-		
	me of potential tree sp	pecies to be used in live fence	Other Information
S. No.	Common Name	Tree Species Scientific Name	Other Information
1.			
2.			
3.			
4.			-
5.			
6.			
7.			
8.			
9.			
10.			

9.	Criteria for selection of tree species for live fence:						
10.	Function of visited live fence						
11.	Diagrammatic representation:						
•	Diagrammatic representation:						
12.	Net amount of money gains by adapting live fence:						
13.	Suggestions:						

14.	Conclusion:						
			Exercise No. 10				
Ob	•	servations to characterize the stru c attributes of the fodder trees and pro					
•	Fodder trees are important feed sources for livestock in a wide range of agroforestry systems throughout the world. Researchers, extension services and farmers have developed and promoted fodder tree practices in many different countries and contexts						
•	Protein banks are fodder banks where trees, shrubs and pasture legumes with high protein-containing leaf biomass are combined. Trees are planted as close as 1 m x 1m and cut regularly to induce maximum herbage production						
•	In this system of agroforestry, various multipurpose trees (protein rich trees) are planted on wasteland and rangelands for cut and carry fodder production to meet the feed requirements of livestock during the fodder deficit period in winter.						
•	planted in or around	system components are multipurpose trees that the farmlands for providing animal feeds. The nilotica, Azadirachta indica, Albizia lebbeck, sbania grandiflora	common components in this				
Fie	eld Exercise:						
1.	Name of the visiting	protein bank sites:					
2.	Date of visit:	Day:					
3.	Locality:						
	-						
4.	Area (m²):						
5.	Geographical location	n:					
6.	Altitude:						
7.	Slope:						
8.	Presence of potentia	al trees in protein bank sites					
	S.	Tree Species	Other Information				
	No. Common Nam	ne Scientific Name					
	2.						
	3.						
			•				
	4.						
	5.						

6	i.									
7	,									
8										
9										
	0.									
1	11.									
9.	Criteri	a for selec	ction of f	odder	trees in	protein bar	nk sites:.			
•										
11.	Functi	on of visit	ed prote	in ban	ık sites					
11	Diagra	ammatic r	onrocon	tation:						
• • •	Diagra		chicaciii	lation.						
12.	Net	amou	nt o	f ı	money	gains	by	adapting	protein	bank:
12	Suga	gestions: .								
13.	Jugg	<sub>ว</sub> ษอนเบทอ								

				 	 		 •
14.	Con	clusio	n:	 	 		 
				 	 		 •
				 •	 	• • • • • • • • • • • • • • • • • • • •	 •

#### Exercise No. 11

## Objective: Studies on Design & Diagnostics (D&D) exercise in agroforestry

- D&D is a methodology for the diagnosis of land-management problems and the design of agroforestry solutions.
- It was developed by ICRAF to assist agroforestry researchers and development fieldworkers to plan and implement effective research and development projects.
- D&D is simply a systematic approach to the application of this principle in agroforestry.

#### **Key features of D&D:**

- **Flexibility**: D&D is a discovery procedure which can be adapted to fit the needs and resources of a wide variety of land users.
- **Speed**: D&D has been designed to allow for a "rapid appraisal" application at the planning stage of a project with in-depth analysis occurring during project implementation.
- Repetition: D&D is an open-ended learning process. Since initial designs can almost always be improved, the D&D process need not end until further improvements are no longer necessary

#### Basic procedures of the Diagnosis and Design (D&D) methodology:

D&D Stages	Basic questions to answer	Key factors to consider	Mode of inquiry
Pre-diagnostic			
Diagnostic			
Design &			
Evaluation			
Planning			
Implementation			

Stı	Studies on <b>Pre-diagnostic &amp; Diagnostic</b> stage under <b>D&amp;D</b> exe	ercise in agroforestry	
Pr	Pre-diagnostic stage:		
1.	1. Planning the study:		
2.	2. Regional reconnaissance:		
3.	3. Land-use system:		
4.	4. Site Selection		
	On the basis of severity of problems:		
	Agroforestry potential:		
	Regional representativeness:		
	Priority by land use systems:		
	a Priority by ragion:		
	Priority by region:		
	Solosted land-use systems:		
	Selected land-use systems:		
Dia	Diagnostic stage:		
	5. Diagnostic survey:		
Ο.	Jugnostio survey.		
6.	6. Diagnostic analysis:		
٠.			

.....

7.	System s	pecifications	s:								
									Ex	ercise No.	. 12
Ok	ojective:	Studies of agroforest		esign	&	Evaluation	stage	under			
Те	chnology		-								
		te technologi	ies:								
					_						
2.	Technolo	ogy specifica	ations:								

3.	Technology Design:
	luation & redesign:
4.	Ex-ante evaluation & redesign:
Suit	ability Classification:

Objective: Studies on Planning & Implementation stage under D&D exercise in agroforestry Planning stage: 1. Research needs: 2. Research and extension plans:

3. Programme implementation:  Conclusion:	lm	olementation stage:
	3.	Programme implementation:
	_	
	Со	nclusion:

### Objective: Assessment of productivity of tree crop combinations

- Agroforestry has attracted considerable attention in recent years because of its potential to reduce poverty, improve food security, reduce land degradation and mitigate climate change. However, progress in promoting agroforestry is held back because decision-makers lack reliable tools to accurately predict yields from tree-crop mixtures.
- Agroforestry systems, containing mixtures of trees and crops, are often promoted because the net
  effect of interactions between woody and herbaceous components is thought to be positive if
  evaluated over the long term. From a modeling perspective, agroforestry has received much less
  attention than monocultures. However, for the potential of agroforestry to impact food security in
  country to be fully evaluated, models are required that accurately predict crop yields in the
  presence of trees.

#### Field Exercise:

1. Presence of agroforestry tree species in the sites

S.	Tree	e Species	No.	Uses	Dist	ance	Other Information
No	Common Name	Scientific Name			Rows (m²)	Plants (m²)	
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							
13.							
14.							
15.							

2.	Criteria for selection of tree species:

3. Identification of agroforestry systems (On the basis of structure and fund	ა.	vstems (On the basis of structure and function):	identification of adroforestr
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Name of agroforestry		Components				
system	Trees		Pasture			
Agri-silvi						
-						
Silvi-pasture						
Agri-silvi-pasture						
Others						
	system Agri-silvi Silvi-pasture Agri-silvi-pasture	Silvi-pasture  Agri-silvi-pasture  Agri-silvi-pasture	Silvi-pasture  Agri-silvi-pasture  Agri-silvi-pasture			

# 4. Productivity of agroforestry systems:

S.				d/ year)	Total income
No.	agroforestry system	Trees	Crops	Pasture	
	Agri-silvi		•		
	-				
	Silvi-pasture				
•	Silvi-pasture				
	-				
	-				
3.	Agri-silvi-pasture				
	Others				

5.	Diagrammatic representation:
6.	Suggestions:
7.	Conclusion:

# Objective: To study resource partitioning in agroforestry systems - water, light and nutrients

- Agroforestry is based on the premise that land-use systems that are structurally and functionally
  more complex than either crop or tree monocultures result in greater efficiency of resource
  (nutrients, light, and water) capture and utilization, and greater structural diversity that entails tighter
  nutrient cycles. While the above- and belowground diversity provides more system stability and
  resilience at site level, the systems provide connectivity with forests and other landscape features
  at landscape and watershed levels.
- In agroforestry, tree and agricultural crops are combined together and they compete with each other for growth resources such as light, water and nutrients. The resource sharing by the components may result in complementary or competitive effects depending upon the nature of the species involved in the system, the manner in which they are grown and depending on the climatic factors, plants and trees may influence neighboring species, not only by the addition or removal of some factor, but also by affecting conditions such as temperature, light or wind movement or by altering the balance between beneficial and harmful organisms.
- Opportunities for substantial temporal complementarity exist for storable resources like water and nutrients in a system if major resources demand is at different times. On the other hand for unstorable resources like light spatial complementarity is the only phenomenon available.

#### **Exercise**

1. Availability of light and their importance in agroforestry systems

2.	Availability of water and their importance in agroforestry systems	• •
		• •
		• •
		• •
		••
		••
		••
		• •
		••
••••	A	••
3.	Availability of nutrients and their importance in agroforestry systems	•

### Objective: Analysis of organic carbon for given plant / soil samples

- Soil organic carbon is also important to chemical composition and biological productivity, including fertility and nutrient holding capacity of a field.
- As carbon stores in the soil increase, carbon is "sequestered", and the risk of loss of other nutrients through erosion and leaching is reduced.
- An increase in soil organic carbon typically results in a more stable carbon cycle and enhanced overall agricultural productivity, while physical disturbances of the soil can lead to a net loss of carbon into the surrounding environment due to formation of carbon dioxide (CO<sub>2</sub>).

Principle:
Methods:
Reagent required

Procedure:
Calculations:
Interpretation:

### Objective: Analysis of nitrogen (N) for given plant / soil samples

- Nitrogen (N) is an essential macro element required for the success of all known life forms, including cannabis plants. N acts as a key catalyst to support photosynthesis and other important biochemical reactions required for healthy cannabis growth. For example, N is a key elemental component in chlorophyll-the biomolecule which allows plants to absorb energy from light (i.e. photosynthesis) to facilitate growth.
- Most plants take up nitrogen continuously throughout their lives, and plant nitrogen uptake
  usually increases as plants increase in size. Because of the importance of nitrogen in crop
  growth and for fertility evaluation, the determination of nitrogen in soil/plant hold important place.

Principle:	
Reagents and Apparatus:	

Procedure	
Observations and Calculations:	
Interpretation:	
Interpretation:	

### Objective: Analysis of phosphorus (P) for given plant / soil samples

- Phosphorus is an essential macro-element, required for plant nutrition. It participates in metabolic processes such as photosynthesis, energy transfer and synthesis and breakdown of carbohydrates.
- Phosphorus is found in soils both in an organic form and an un-organic (mineral) form and its solubility in soil is low. There is equilibrium between solid phase phosphorus in soil and the phosphorus in the soil solution.
- Plants can only take up phosphorus dissolved in the soil solution, and since most of the soil
  phosphorus exists in stable chemical compounds, only a small amount of phosphorus is
  available to the plant at any given time.

Principle:	
Methods:	

Reagents:	
Procedure:	
Calculations:	
Calculations:  Interpretation:	

### Objective: Analysis of potassium (K) for given plant / soil samples

- Next to nitrogen, potassium is the mineral nutrient required in the largest amount by plants. The potassium requirement for optimum plant growth is in the range of 2-5 per cent of the vegetative parts fleshy fruits and tubers of plants (oven dry basis).
- Now-a-days, due to intensive cropping systems as well as use of modem agro-techniques the
  higher rate of application of potassic fertilizers is employed. In order to maintain the fertility level of
  a soil, the amount of K+ taken up by plants and lost by leaching should at least be balanced by
  potassium fertilization. However, in highly developed agricultural systems, reserve potassium in
  soils is being depleted.

Principle:	
Depotion	
Reaction	

Reagents and Apparatus:	
Procedure:	
Calculations:	
Interpretation:	