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M Kanwat

ICAR RC for NEH Region AP
Centre, Basar, Arunachal
Pradesh, India

RA Alone

ICAR RC for NEH Region AP
Centre, Basar, Arunachal
Pradesh, India

D Jini

ICAR RC for NEH Region AP
Centre, Basar, Arunachal
Pradesh, India

H Kalita

ICAR RC for NEH Region AP
Centre, Basar, Arunachal
Pradesh, India

S Kumar

ICAR RC for NEH Region AP
Centre, Basar, Arunachal
Pradesh, India

Naveen KH

ICAR RC for NEH Region AP
Centre, Basar, Arunachal
Pradesh, India

Corresponding Author: M Kanwat

ICAR RC for NEH Region
AP Centre, Basar,
Arunachal Pradesh, India

A study of farmers innovativeness towards the adoption of agro forestry system in NEH region with special reference to Arunachal Pradesh, India

M Kanwat¹, RA Alone², D Jini³, H Kalita⁴, S Kumar⁵, Naveen KH⁶

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ABSTRACT

It has been widely documented that the traditional farming system of shifting cultivation contributes to huge annual losses of forest cover, altering the structure and distribution of species resulting in loss of biodiversity. On the other hand, formal institutional approaches to natural forest biodiversity conservation focused on protecting the tree species in parks and reserves while neglecting their conservation in farming systems. Improved agroforestry systems (AFS) such as improved fallows that mimic shifting cultivation and other AFS provide benefits that contribute to rural livelihoods, improved socioeconomic status and ecosystem functioning of land use systems. Recently, there is an increasing recognition of the contribution of agroforestry to improve ecosystem services and livelihoods especially in rural areas. Compared with subsistence agriculture, AFS provides added benefit by generating cash income from the marketing of diverse products. In Arunachal Pradesh, research that aims to address biodiversity and socio-economic issues includes domestication of indigenous forest trees with Agroforestry technologies. This paper discusses the contribution of the natural forest resource and Agroforestry system to the improvement of the socio-economic livelihoods of smallholder farmers and the promotion of the conservation of biodiversity drawing on evidence from research conducted in developing countries especially in Asian region over the last two decades.

Keywords: Agroforestry systems, Biodiversity, Ecosystem, Livelihoods, Socioeconomic, Forest resource

1 Introduction

Farming or agriculture is the main source of livelihoods for the people of Arunachal Pradesh. Trees play an important role in ecosystem to all terrestrials and provide a range of products and services for rural and urban people such as natural resources, land, water and vegetation can conserve and occupy center-stage for the welfare and development of people through agroforestry. Their livelihood strategy may mix on farm and off-farm work, where they extract timber and non-wood forest products (including fodder) from nearby forests and/or communal lands. They produce for their own consumption as well as for the market. Some key features of such integrated livelihood systems include risk mitigation, labour distribution, intimate links between agriculture and social and institutional factors, use of traditional knowledge, and customary tenure systems. According to Dixon *et al.* (2001) [1], farming systems are characterized by structural complexity and external relationships between various components of a small-holding, which are also influenced by the external environment, including policies and institutions, markets and information linkages. Increasing demand for livestock foods offers countless opportunities for improving resource-poor farmers. Rapid urbanization, high income and population growth in developing countries are driving forces explaining this expansion (Delgado *et al.*, 1999) [2]. Adoption of agro-forestry is an alternative to high-cost inputs such as chemical fertilizers, herbicides, insecticides and pesticides since it offers opportunities of improving the quality of life of resource poor farmers, while ensuring the sustainability of the natural resources base and the environment (Govere, 2003) [3]. Resource-poor farmers are not able to meet properly this livestock market expansion unless sustainable-oriented technologies and policies are addressed.

In the West Siang, resource-poor farmers based on live stock face serious difficulties to sustain their family livelihoods. Significant poverty levels, emigration and resource degradation are critical (Cunha *et al.*, 1994) [4]. There is strong evidence that agro-forestry can be an alternative strategy to recover fundamental components and attributes of ecosystems while reducing poverty and food insecurity for thousands of smallholders in developing countries (Arnold, 1999) [5]. Agroforestry development programs that address farmers' self-efficacy about agroforestry may increase the probability that farmers will maintain the practice in the future. This paper attempts to provide a sound understanding of the socio-economic process occurring in livestock-based smallholder systems in the Basar subdivision of West Siang in order to identify opportunities for

proper technological and policy interventions. Firstly, aspects of sustainability of the system are analyzed via assessing linkages between farmer's management decisions and attributes of ecosystems. Secondly, agroforestry models are simulated to assess impacts on the family income level and farm resources allocation. The paper also highlights some problems encountered in promoting agroforestry for sustainable livelihoods and maintenance of biodiversity.

Research Method

The study area

Anjaw district is a mountainous tract. It spread at an area of 7643 sq. km boarding Upper & East Siang at East, China towards North, Upper Subansiri to Western & Assam at South. The district is lying approximately between 94° to 00° E & Latitude 28° $150'$ N and 29° of longitude. The altitude of this district varies from nearly 500 feet at the foothills to 1000 feet above MSL. Daily mean temperature ranges from a maximum of 38°C in the month of June and minimum temperature drops to 6°C in the month of December. Rural sedentary populations represent 57%, the nomad 24% and only 19% are urban population. The study area receives average rainfall of 2930 mm with high degree of temporal and spatial variations. Rice, Maize and Mustard, potato, are the main agricultural crops grown in Siang region, in addition to field and horticultural crops different types of livestock such as cattle, poultry and pigs. The study was conducted in Anjaw of Arunachal Pradesh state, where the ICAR activities was implemented. As the villages are scattered over a large area and there are no paved roads between them and transportation is very difficult, About thirty six villages in these subdivision are included in the 80 Gram Panchayats covered under this study and farmers in these villages were involved in agroforestry based farming system.

Sample selection and data collection

Ten villages were selected randomly from this Basar subdivision which is fully dominated by *Mishmi* tribal groups. In each selected village thirty farmers were selected randomly. Thus, random sample of 300 farmers was selected from the proposed study area.

The data was collected through face to face interviews using a questionnaire that was pre-tested and validated. The questionnaire included questions about the farmers' socioeconomic characteristics and farming practices. Frequency distribution and multiple regression analysis were used to analyze the data using the Statistical Package for Social Science (SPSS) 20.0 version.

Measurement of some of the theoretical concepts

Farmers' innovativeness of Agroforestry farming System: Innovativeness is defined as "the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than the other members of a system" (Rogers, 1995) [6]. In general, it is recognized that quantification of adopters' innovativeness of natural resource sustainable management practices such as agroforestry farming system is elusive since partial and incremental adoption by farmers makes precise measurement difficult (Ajayi, 2007; Franzel *et al.*, 2002) [7, 8]. In this study farmers' level of adoption of agroforestry farming system measurement is based on Ajayi *et al.* (2003) [9] idea of agroforestry adoption continuum on which farmers occupy positions depending on the extent to which they have taken different steps towards full adoption of the technology particularly the area of the field devoted to agroforestry. Consequently, an adoption scale that ranges from 1 to 5 is used. Farmers who did not practice agroforestry were given a score of zero, those who devoted between 1% and less than 25%, 25% - less than 50%, 50% - less than 75% and 75% - 100% were given scores of one, two, three and four respectively. Farmers' education measured by the number of years of formal education the farmer completed. Educational status was operationalized as the extent of formal education received by the respondent. The respondents were grouped into three categories on the basis of their education level and for Illiterate farmers we have given 0 marks, 2

marks for the farmers which his studied up to primary level and 3 marks for those who studied Middle and above level. Contact with extension agent total number of visits made by the respondents to extension office or the visits made by the extension agent to the farmers either individually or in group in month. Extension contacts explore by the respondents were score like Low extension contact (0-1 month) Medium extension contact (1-2/month) and for high extension contact (more than 2/month). Environmental awareness measured by the total number of environmental problems mentioned by the farmers. Each environmental problem (e.g. deforestation through jhum farming, flood, land degradation, soil erosion etc.) mentioned by the farmer was given a score of one. Farmer's cosmopolitaness measured by the total number of visits to any city that the farmer had made during the last year.

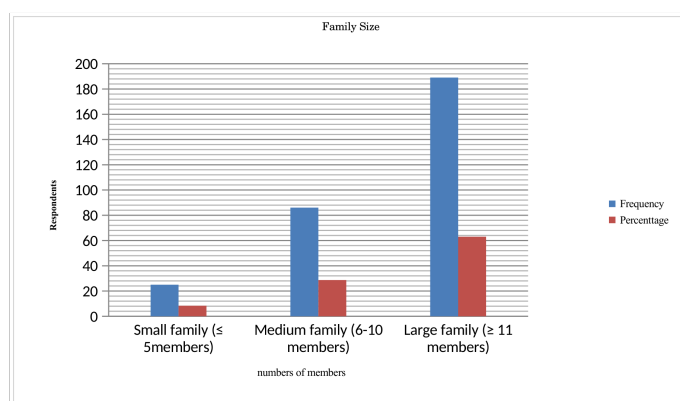
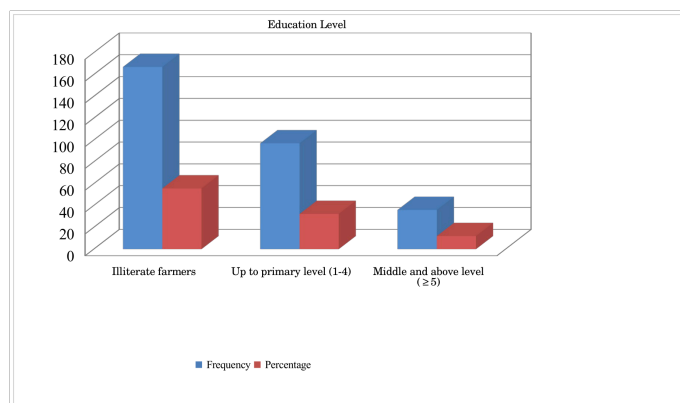
Social participation measured by the total number of social organizations the respondents was a member in, the number of offices the respondent took in the social organizations in which he was a member and the number of voluntary activities in which respondents participated in during the last year.

Results and Discussion

The respondents' some socioeconomic characteristics

Table (1) indicates that a high percentage (42.7%) of the respondents are of young age (≤ 40 years) compared to about one fifth (21.0%) who exceeded 60 years of age. According to the adoption theory this represents a good ground for the success of extension campaigns and programs that aim at dissemination and adoption of any agricultural innovations, particularly those intended for environment conservation and natural resource sustainable management, as young farmers have been found to be more innovative than their older counterparts (Rogers, 1993). On the other hand, it has been found that about two thirds (66.0%) of the respondents did not attend any formal education (table 1). Since illiterate farmers are less innovative than their literate fellows, this high rate of respondents with no formal education is expected to represent a major constraint to the efforts exerted to disseminate the agroforestry farming system and convince farmers to adopt it. While about two thirds (68%) of the respondents had small families that are composed of five or less members, only 1.3% of them had large families that consist of eleven or more members. The effect of the family size on the farmer's adoption of agroforestry farming system labor in this part of Sudan and as adoption of agroforestry farming system demands more labor, larger families are expected to be more innovative than small families. On the other hand, as farmers depend for their food needs on their own production; large families are expected to plant fewer trees on their farms as they need to devote most of their land to production of food crops such as sorghum and millet. The majority (68%) of the farmers possess medium size farms that range between 11 – 25 Mukhamas in size. Large farms will make more land available for trees plantation and adoption of agroforestry farming system will not be perceived at the expense of household food security.





Determinants of respondents' innovativeness

The variables included in the agroforestry farming system adoption model (Table 2) explained 68.4% ($R^2 = 0.684$) of the total variation in the respondents' innovativeness regarding adoption of agroforestry farming system. As adoption of agroforestry farming system is a complicated phenomenon (Ajayi *et al.*, 2007; Franzel *et al.*, 2002) [7, 8], this is considered a powerful regression model ($F = 55.712$; $P = 0.000$).

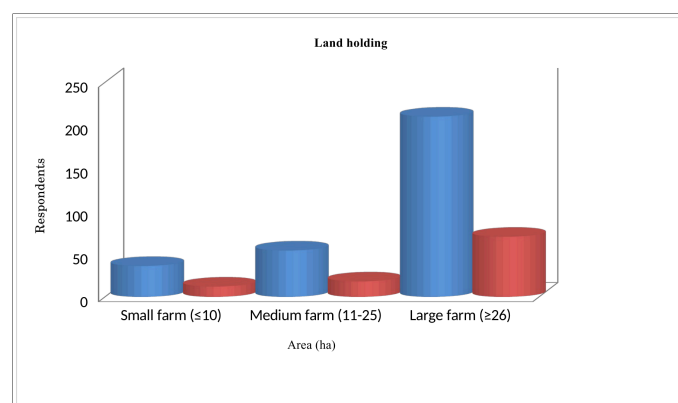
Table 1. Some of the respondents' socioeconomic characteristics

Socioeconomic characteristics	Frequency	Percentage
Age:		
≤ 40 years	157	52.23
41-60 years	90	30.00
≥ 61 years	53	17.67
Total	300	100
Years of formal education:		
Illiterate farmers	167	55.67
Up to primary level (1-4)	97	32.33
Middle and above level (≥ 5)	36	12.00
Total	300	100
Family size		
Small family (≤ 5 members)	25	8.33
Medium family (6-10 members)	86	28.67
Large family (≥ 11 members)	189	63.00
Total	300	100
Area of land owned		
Small farm (≤ 10)	36	12.0
Medium farm (11-25)	54	18.0
Large farm (≥ 26)	210	70.0
Total	300	100

As expected farmer's level of formal education is the most important significant explanatory variable of the respondents' differential inno-

vativeness. This is logical and consistent with the adoption theory and previous literature, as educated farmers usually have access to more information sources, can comprehend and benefit more from extension messages and are usually more aware about environmental problems (Rogers, 1993; Haggblade *et al.*, 2004) [10]. The second important determinant of the farmers' agroforestry differential rate of innovativeness is the degree of their contact with the extension service. This can be through the extension agent visits to the farmers or the farmer visits to the extension office seeking information and advice. Agricultural extension is considered a type of informal adult education that is intended to enhance farmers' knowledge in certain areas and enables them to benefit from available agricultural technologies and improved practices. In this way, the extension service supplements the deficiency in the farmers' formal education. Thus, the significant positive effect of both farmers' education and contact with the agricultural extension service is consistent, logical, expected and in line with previous literature (Ajayi *et al.*, 2007; Kuntashula, *et al.*, 2004; Mekuria and Waddington, 2004) [7, 11, 12]. Farmers' level of environmental awareness represents the third important factor in the hypothesized agroforestry adoption model. Farmers' level of environmental awareness is expected to be influenced positively by their educational level and degree of contact with the agricultural extension service, so it is logical that its effect on the respondents' innovativeness to be positive. Thus, it is recommended that future research should use more advanced analytical models such as path analysis to divide the total effect of the exogenous variables, such as personal characteristics and policy variables, on the respondents' level of innovativeness into direct effect and indirect effect through intervening variables. This will help in understanding the causal mechanisms through which the different variables affect farmers' innovativeness which is very useful in designing extension programs for enhancing adoption of such innovations. Agricultural extension programs that aim at enhancing adoption of environment conservation innovations usually place great emphasis on raising the target population level of environmental awareness as a key factor for realizing its' objectives. This (i.e. the importance of environmental awareness) is confirmed by this study. The fourth important explanatory factors of the variation in the farmers' level of innovativeness regarding adoption of agroforestry farming

one pura = 0.73 hectare



system is the respondents' cosmopolitanism. Farmers' cosmopolitanism can be perceived as proxy of their openness and exposure to different sources of information which are important correlates of high level of innovativeness. The total area of owned land ranked as the 5th important significant determinant of the respondents' innovativeness. One of the main constraints of agroforestry adoption is the perception that trees compete with agricultural crops for land particularly when the size of holding is small. This perception will not hold true when the size of the farmers holding is large enough to accommodate both agricultural crops and trees. The last significant predictor of respondents' innovativeness is their degree of social participation. Since Social participation is measured by the total number of social organi

zations the respondents was a member in, the number of offices the respondent took in the social organizations in which he was a member and the number of voluntary activities (e.g. building of *Dere*, community fencing, for helping others etc.) the respondents participated in during the last year, it can be used as a proxy for the respondents' exposure to different sources of information and socioeconomic status which are both important determinants of innovativeness. Although

the other variables included in the regression model (number of family members who work in agriculture, family size, cultivated area, No. of hired labors and age) did not have a statistically significant effect on the respondents' innovativeness, yet the sign of the regression coefficient of all of them is as expected which supports the theoretical arguments on which the adoption model is based.

Dependent variables	Independents variables	β value	Sig.level
Farmers innovativeness	Education	.364	.000
	Contact with extension agent	.209	.002
	Environmental awareness	.137	.002
	Farmers cosmopoliteness	.117	.007
	Total area of control land	.122	.012
	Social participation	.116	.021
	Number of family members who work in agriculture	.158	.062
	Family site	-.078	.127
	Cultivated area	.066	.202
	No. of hired labour	.072	.428
	Age	-.035	.655

$R^2 = 0.684$; $F = 55.712$ ($P = 0.000$)

Conclusion

Farmers' adoption of agroforestry farming system in Anjaw district, Arunachal Pradesh state is found to be significantly affected by the farmers' level of formal education, contact with extension agents, level of environmental awareness, cosmopoliteness, total area of owned land and extent of social participation. The fact that the farmers' level of formal education, contact with extension agents and level of environmental awareness are the three most important determinants of the farmers' differential rate of innovativeness regarding adoption of agroforestry farming system reflects the important role that extension programs can play in enhancing adoption of natural resources sustainable management innovations. Moreover, it is recommended that future research in this area use more advanced analytical models such as path analysis model to determine the causal mechanisms through which the different variables influence the adoption process so as to be able to determine the appropriate interventions and policies for enhancing farmers' innovativeness.

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