

Multifunctional agriculture as a holistic tool in addressing sustainability issues among mountain communities of Ziro valley, Arunachal Pradesh

Santanu K. Patnaik, Arunachal Pradesh

Abstract

Multifunctional Agriculture is a viable concept to perceive and reap the benefits of agriculture in a multifarious way. With shrinking income from agriculture and a target to double the income from agriculture; it is imperative that agriculture must be viewed in a holistic manner; especially by combining various sectors like social, cultural, economic and their linkages with agriculture. With the changes in livelihood patterns and choices, high input cost and low remuneration of agricultural produce, low man-environment care and concern, rural exodus for various reasons, the countryside is gradually becoming deserted for modern amenities in urban areas. In a state like Arunachal Pradesh, among the mountain communities, the traditional man-environment bonding is giving way to modernization and that is resulting in insecure livelihood options and detachment from tradition and nature. Most of all, the sustenance of long drawn and stabilized traditional cultural practices are at stake. One of the solutions envisaged is, switching over to a system without disturbing the roots. The traditional agricultural system can be used in a multifaceted manner so as to retain rural livelihood, maintaining a steady income and negating the push factor for migration. As a case study, Ziro Valley of Arunachal Pradesh has been taken as a template. During the last two decades Ziro valley, rich with traditional cultural practices revolving around paddy cum pisciculture and lustrous environmental surroundings has developed symptoms of degeneration of traditional way of life, exploitation of natural resources beyond the capacity of regeneration for economic need and has become a concern for the natives themselves. A blueprint on 'multifunctional agriculture' as a way forward and as a tradeoff between economic need and conserving nature and tradition has been worked out, on the basis of a knowledge base covering activities among mountain communities, preferred land use activities, several research expositions, field visits, interactions with the elder and younger generations, geo-environmental propensity and endowment.

Keywords: Multifunctional Agriculture, Mountain Community, Arunachal Pradesh, paddy cum pisciculture.

Introduction

Keeping abreast with a better system is the ultimate aim of any community and hence they are in various phases of perpetual transition. In India, Countryside in India

depends heavily upon agriculture, but with the diversification of the economy, employment in agriculture has gone down from 59.6 percent in 2000 to 51.5 percent in 2010 to

42.3 percent in 2020 (World Bank, 2020). The fluid situation during transition has affected the sensitive mountain communities. Their livelihood, economy, culture and tradition are under threat due to pressure to augment their income and assimilate into popular culture due to changes in livelihood options and lifestyle. Mountain community in Ziro Valley, Arunachal Pradesh, India, is no exception. Apatani society of Ziro valley does not treat agriculture in isolation. It is linked with their social ethos, conduct and livelihood. Traditional Ecological Knowledge (TEK) bases of the community have regulated and helped them to maintain their economy, water and land resources, healthcare and social bond. With growing pressure from modernization of the society, the traditional agricultural system is no longer able to support their financial need. This has resulted in the expansion of agricultural areas very close to the hill base, utilization of hill slopes for horticulture causing undue stress on the environment leading to degradation through the landslide, soil erosion and sedimentation in lower reaches. A holistic integrative approach-Multifunctional Agriculture-has been charted out in this paper for a secure livelihood, augmented income, sustained cultural and traditional practices, within a sustainable ecological and landscape framework for the mountain community.

Conventional agriculture and its limitations

Conventional 'agriculture' has been perceived to have a sole purpose i.e. the production of food and fiber. Agricultural produce is measured in terms of productivity: acreage and yield. The success of agricultural output depends upon availability, adequacy and quality of agricultural inputs such as land, water, seeds

and fertilizers, access to agricultural credit and crop insurance, demand and remunerative prices for agricultural produce and storage and marketing infrastructure to name a few. With this system and agricultural policies, the developed nations became self reliant and achieved food security; developing countries like India could expand agricultural land, start a green revolution to bridge the gap between demand and supply of food crops.

During the early 19th century, aided by better transport system for world trade of agricultural produce and increasing globalised nature of agro-commodity chains; mechanization of agriculture transformed 'traditional agricultural system' into an efficient and labour-saving 'industrial agriculture' often characterized by mass production of uniform and standardized food products (Mazoyer and Roudart, 2006). Due to non-inclusion of environmental concerns, sustainability issues started weighing more than simple economic development and a paradigm shift came to the fore in the form of the Brundtland report (WCED, 1987) that states "industrial gases threaten to deplete the planet's protective ozone shield to such an extent that the number of human and animal cancers would rise sharply and the oceans' food chain would be disrupted, industry and agriculture put toxic substances into the human food chain and into underground water tables beyond reach of cleansing". However, critics have argued that the report is looking for "continuation of the same basic values, systems and strategies, which are the very roots of the problems to which the report was intending to offer solutions" (Trainer, 1990). These are views of "productivism" that is defined as "a commitment to an intensive, industrially driven and expansionist

agriculture with state support based primarily on output and increased productivity” (Lowe, et. al, 1993). Contrary to these rigid, harsh and coercive stances in agricultural development policies, post-productivism thoughts evolved to “involve reduced intensity of farming, less environmental damage and a shift towards sustainable agriculture and conservation or restoration of valued landscapes and habitats (Wilson, 2001).

Multifunctional agriculture: a gateway

These entire evolving and juxtaposing scenarios led to theorizing and integration of the ‘economic’ production system with other visible or invisible functions of agriculture. The nebulous debate over productivism and post-productivism and a plethora of definitions, opinions and policies of various Governments about initial concept and haziness about the inclusion of other functions have been covered well (Wilson, 2007). While in some parts of the world experiments of integration of agriculture with amenities, ecosystem services and preservation of local or regional cultural landscapes (McCarthy, 2005; Wilson & Rigg, 2003) were going on; India, due to its heavy dependence on agriculture has been concentrating on the expansion of cultivable space. Other dimensions that contributed to the expansion of agriculture included horizontal expansion of cropping land, multiple cropping, plantation agriculture, mixed farming and late vertical farming. These have been practiced with the help of local entrepreneurship or government schemes and subsidy leading to the absence of reaping benefits of various invisible components of agriculture and continuance of the productivist realm. The emerging thought of “post-productivism” is a term that is closely related to the ‘new way’

of looking at rural areas, referred to as the ‘new rural paradigm’ (OECD, 2006).

The emergence of the concept of multifunctional agriculture is targeted to include social, cultural, ecological and environmental components and factoring it into rural development in a sustainable manner. The modern farmer is seen as an environmental manager, a producer of food and fiber (Marsden, 1999). It is also perceived that rural development is more compatible with regional or territorial perspectives than sectoral perspectives as many planners perceive (Zander, et.al., 2008; Sumelius et.al. 2008). Despite all these policy prescriptions, the valuation of agriculture in terms of ‘green prices’ is essential (Randall, 2002). Some important observations about this kind of agriculture are: multifunctional agriculture is a policy, practice and discourse that aim to preserve and conserve rural spaces, the cultural landscape, and the farming way of life and food safety (Bjørkhaug, et.al. 2008). A comprehensive conceptual framework can be depicted through this model conspicuously depicting: a) blue services – comprising management of water supply and water quality, flood control, efficient use of water; b) green services – consisting of landscape management and the wildlife management, maintenance of biodiversity, improvement of nutrient recycling; 3) white services – food production and food security and finally 4) yellow services – encouraging rural cohesion and development, agro-tourism and agro-entertainment coupled with native tradition and heritage (Figure 1)

It has been observed that government policies are not in tandem with the integration of multifunctional activities with real rural development (Marsden, 2008). The rural

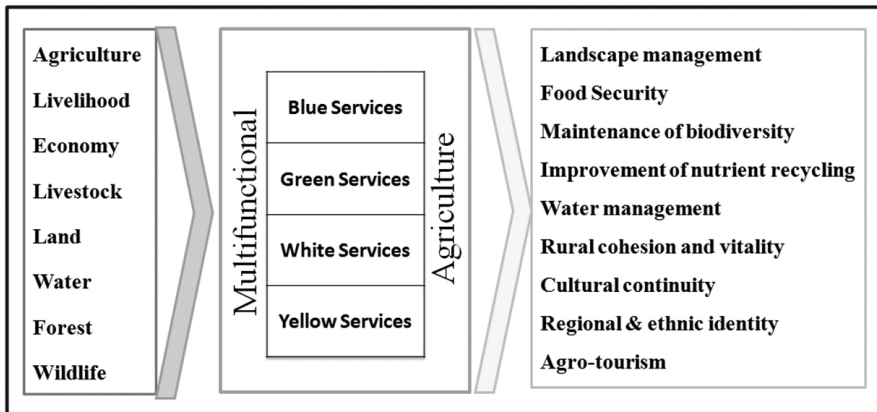


Figure 1. Comprehension of multifunctional agriculture model

transformation and regeneration of rural cultural heritage can be achieved through multifunctional agriculture (Piccinno, 2019). Besides the lack of any policy, another aspect of non-promotion of multifunctional agriculture is the absence of valuation of agricultural enterprises through “green prices” and through “green payment system” (Randall, 2002). These are the tickling issues associated with multifunctional agriculture, which will be explored through the prism of the mountain community and their yellow services.

Mountain and imposing limitations

Mountains constitute about 27 percent of the landmass on earth. Arunachal Pradesh, located in the northeastern part of India is a mountainous state in the Great Himalayan Range. The high magnitude mountain building process has resulted in rugged topography, mighty rivers, a mosaic of climate patches ranging from a humid tropical climate to alpine climate regime, a plethora of biotic diversity and a negligible human occupancy. Mountain environment thus has posed severe encumbrance.

One of the extreme disadvantages of Arunachal Pradesh is its terrain condition. With limited patches of land available for agriculture and hardly any scope of secondary activities; agriculture, fishing and hunting have been the only occupation of native people till a few decades back. It has its population dispersed due to inaccessibility, with a population density of 17 per km² (Census 2011). As there is the growth of population of about 26 percent between 2001 and 2011, there is a stress on limited land resources. On the other hand, it has the advantages of being a scenic, serene and vast expanse of undisturbed land that is recognized as a biological hot spot. Economically, it is endowed with huge potential for hydropower, forest and agro-based industries, textiles and tourism.

The study area

One of the well-known districts of Arunachal Pradesh is Lower Subansiri covering an area of 3508 km². The altitude of the valley area surrounded by the mountain range varies between 1480m and 2670m. The altitude of the cropped area is between 1560 and 1600m.

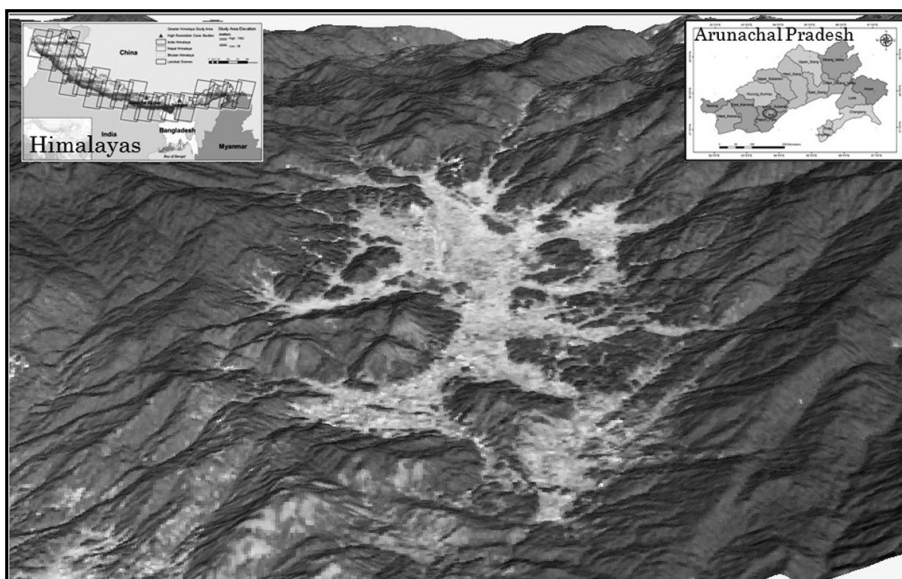


Figure 2. Location and topography of Ziro Valley, Arunachal Pradesh

The Valley is traversed by the Kele River that provides water for irrigation. The Ziro valley (Figure. 2) covers an area of 148 km². Out of this total area, about 91 km² is under forest, about 36 km² is under forest/plantation, about 16 km² is under agriculture and the remaining area of about 7 km² is under settlements. Soil type is very deep, imperfectly fine soil on very gently sloping plain having a loamy surface with slight erosion hazard characteristics. It has good permeability and water retention capacity, which is highly conducive for rice-fish culture (Saikia & Das; 2004). Agroclimatically it is best suited for paddy crop (Table - 1).

This district is rich in valuable species of trees and many varieties of shrubs, bamboo and cane. Forests are of five types: i) Tropical evergreen forests, ii) Sub-tropical forests, iii) Sub-tropical grasslands, iv) Temperate forests and v) Sub-alpine and alpine vegetation. It has great economic value for the people as

well as for the environment with hardwood, softwood, herbal, medicinal, aesthetic properties and rich in biodiversity.

This district is largely inhabited by a native tribe named Apatanis who are good in the traditional agricultural operation, water management mechanism, weaving and handicrafts. There are 144 villages in Ziro Sadar Circle and 88 villages in Ziro Old Circle. Ziro Valley has 35 villages out of which nine villages are prominent viz. Reru, Kalung, Tajang/Lampia, Hija, Dutta, Mudang-Tage, Bamin-Michi, Hong, Hari. All these villages have 2052 households with a total population of 12699 (6177 male; 6522 female). Apatanis have local customary laws and spiritual beliefs revolving around nature.

Ingredients for a holistic approach

Landuse of Ziro Valley

Land use has conformed to the need of the inhabitants of the area and a hotspot for

Table:1 Climate parameters at Ziro, Lower Subansiri District, Arunachal Pradesh

Parameter	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall	mm	11.47	21.42	47.40	136.69	233.25	369.70	398.88	312.41	227.89	99.99	15.62	9.96
Min Temp	°C	3.78	6.07	9.46	12.41	15.25	18.41	19.26	19.07	18.11	14.41	9.38	5.31
Max Temp	°C	17.47	18.85	22.42	23.93	25.34	26.95	27.15	27.10	26.63	24.97	21.91	18.55
Ave Temp	°C	10.61	12.44	15.92	18.15	20.28	22.66	23.18	23.06	22.35	19.67	15.63	11.92
Cloud Cover	%	26.06	36.15	44.69	55.67	62.98	75.73	82.35	80.40	72.23	47.09	30.95	25.64
Wet Day	%	1.37	2.60	3.60	7.08	11.33	13.94	15.06	13.13	10.39	4.86	1.62	1.04
Reference Crop ET	mm	2.07	2.58	3.67	4.27	4.60	4.64	4.47	4.23	3.78	3.25	2.58	2.01
Potential ET	mm	4.00	4.35	5.46	5.91	6.04	5.71	5.42	5.23	4.97	5.01	4.66	4.02

Source: Compiled meteorological data from India water portal (http://indiawaterportal.org/met_data/)

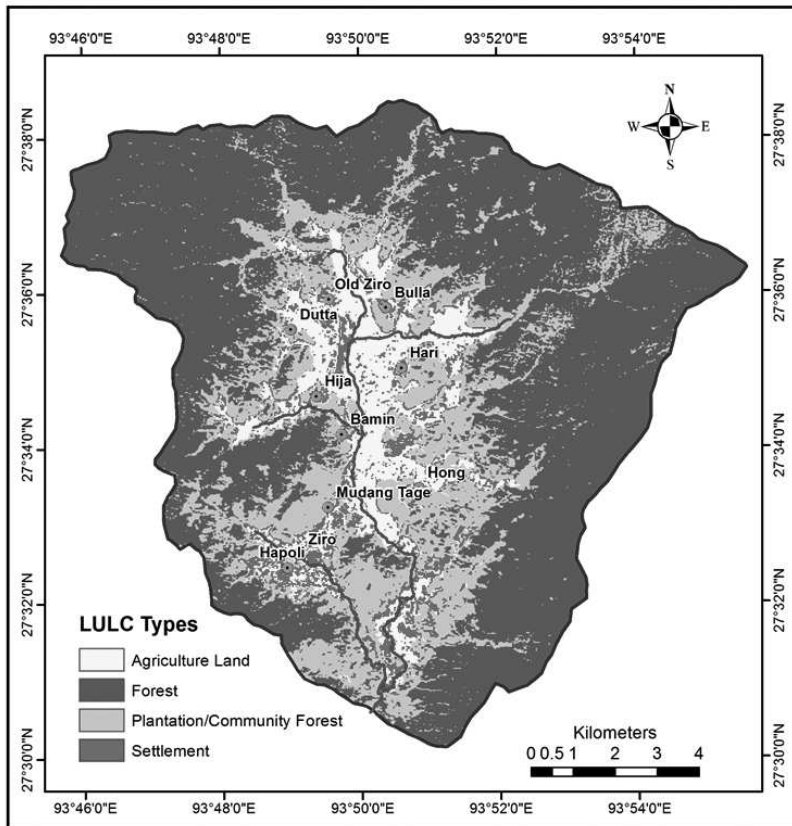


Figure 3. Land Use and Land Cover, Ziro Valley

settlement, agriculture and community forestry. The Ziro Valley area is 148 km² with predominantly four broad land use types: i) Forest (dense), ii) Community/ plantation forest (altered, under horticulture, sparse, bamboo, etc.), iii) croplands, iv) settlement. These are as per the classification of satellite images (Figure 3). The traditional way of utilization pattern of land in the valley is intended to maintain ecological balance and green functions of rural landscape management practices. Therefore, it becomes important to find out the ecological function and sustainable nature of land use patterns in the Ziro Valley.

The traditional Apatani society has a thumb rule for land use in their area. Categorization of lands is based upon their perception of the most appropriate and sustainable use of precious and limited land resources. The land is categorized into four major types (Table-2) and several sub-types (Dollo, et.al.2009). Each category has its ecological significance and is being practiced and followed for generations.

Agriculture and Livelihood

Apatanis grow 16 varieties of rice in the waterlogged paddy fields by means of organic farming (Kala, C. P. et.al, 2008). They are engaged in agriculture-pisciculture; have a strong sense of soil and water conservation and management system through an indigenous knowledge system. They reap the good harvest with yield, five times higher than the state average (Dollo, et.al. 2009, Reena et.al. 2014). Pisciculture is not practiced as a commercial venture by the people, as the economy of the native people is only about self-sufficiency and sustenance. Production of fish per hectare of land ranges from 200 to 550 kg per hectare with a market value

of INR40000 (Reena, et.al.2014, Tangjang, et.al 2015). It is an energy-efficient agro-ecological system and has an immense scope (Rai, 2005, Nath, K. 2015).

The population of Ziro Sadar and Old Ziro between 2001 and 2011 has increased by 142.6 percentage. Barthakur (1973) calculated that the average household land holding size is 2.42 acres (on the basis of 1961 Census Series XXIV N35FA Part-II-A Page - 105 – 108). There are a total of 4835 households in Ziro (Sadar) with a population of 22747; Old Ziro has 3274 households and a population of 19605 and the town has 3004 households with a population of 12806 as of 2011. That shows the pressure on land since the inception of pisciculture. In a recent study by Patnaik (2017) landholding is heavily concentrated for marginal (52 percent) and small farmers (44 percent) i.e. with landholding below 1 hectare and 1-2 hectare respectively and average crop field size is 0.247 hectares.

A holistic study was initiated by P. S. Ramakrishnan (1992) on agro-ecosystem and village ecosystem functions; succession patterns and processes; management implications on shifting cultivation as well as the agricultural system of Ziro Valley. It is a fact that paddy cum pisciculture is an ecologically feasible livelihood practice. However, it is gradually becoming economically unviable due to pressure on land, fragmentation of land as per community inheritance law; few households (18.8%) engaged exclusively in farming (Patnaik, 2017) and many looking for opportunities to switch over to Government jobs. This necessitates understanding implications of sustainability issues of the natural environment of the valley, economic standing and livelihood options of the native

people. At a holistic level, these are essential for food security, nutrition sufficiency, which is termed as ‘white functions’.

Agriculture and water management system

Ziro Valley is an intermontane valley with loamy sand, loam, clay loam soil. The organic carbon content ranges from 0.11 % to 6.10% depth of soils that varies from 12cm to 185cm. (CGWB, 2013). Paddy fields cascade down from the foothills and follow the gradient and the channels. Water flow during cultivation is regulated by the indigenous system for efficient water delivery mechanism, without any right to impound or divert water for irrigation. The fish habitat is maintained with standing water and in return provide nutrient for the paddy crop. The community does not allow the use of fertilizer or pesticides by any beneficiary; thereby maintaining overall uncontaminated water supply through all the crop fields. This is a marvelous indigenous practice in reaping the benefits of blue functions of agriculture, i.e. in checking soil erosion, maintaining efficient nutrient cycling and maintaining the aquatic ecosystem services. In the event of a weakened traditional community authority; the whole system may collapse and impact the livelihood, productivity, nutritional status of the native community.

Agriculture vis-à-vis Social function

Apatani belongs to the Tani group who worships Sun and Moon. As per traditions they have tiers of hutments, bamboo and pine grooves on low slopes and forest tracts on higher slopes. They still do not use mechanized farming, not even they use animals for ploughing. Forests and animals have significant value in their societal functions (Blackburn, 2008). Apatani culture

revolves around their surrounding landscape. “Dree” festival is a community festival linked to farming, protect the crops and ensure the well-being of human beings. It is celebrated in July once the plantation of all crops is over; paddy, millet etc. A couple of persons from each community/clan are appointed to conduct rituals; collect a small quantity of rice or millet from each individual in the village in order to meet the expenditure of the ceremony. Myoko Festival, a springtime festival is related to themes like fertility and prosperity. It is a social festival for friends, kith and kin. The God Donyi is prayed for the protection and prosperity of mankind. Tamu is prayed to protect the plants from harmful pests and insects, while Metii is prayed for controlling famine and epidemics, and Harniang is prayed for keeping the soil stable and preventing the paddy plants from getting dried. This describes the essence of societal functions are intertwined with the available resources, environment and paddy cultivation.

A compilation by Database for Indigenous Cultural Evolution (DICE) (University of Missouri, 2015) on Apatani states: “The sun rises and the emergence of the earth and sky follow. Then the greening of the earth happens. Bamboo expands to call ancestors and spirits to feast. Water and fish are created. Then the humans were created”; that describes a nature-man relationship exists. It has a greater functional relationship with the concept of a cultural landscape. The concept of a sacred landscape is a model that could be effectively used for ensuring community participation in sustainable development (Rai, 2007). The integrative social mechanism keeps the cultural cycle moving in a smooth manner. The value of integration of cultural landscape and practices with agriculture

has been recognized and termed as yellow functions.

Agriculture as an Economic function

Agriculture is the economic backbone for the existence of the inhabitants of the Valley. The prosperity of the people is dependent on the prosperity of agriculture and the possession of wealth in the form of land. Fragmentation of land has resulted due to the increase of households. Cropland adjacent to the road and township is gradually converted to residential and commercial land due to a surge in economic value influenced by greater demand. Income from crop fields is at the sustenance level. Very little is sold in the market as a Geographical Indication (GI) Ziro Rice. Mishra and Mohanty (2004) in a study found that a net profit of Rs. 10,781.00 ha⁻¹ was achieved from a dual production system of rice-fish culture similar to the practice by the Apatani in Ziro Valley.

Scenic beauty has made Ziro Valley place an attractive tourist destination. UNESCO has been provided with a dossier since 2014 for awarding the UNESCO World Heritage tag. Its unique green agriculture landscape, encircling picturesque blue mountains, sky speckled with bright and shining cloud, traditionally dressed native Apatani are key attractions. There is the rush of tourists during the months between December to May. A survey by the Ministry of tourism during 2014-15 found there were 82.7 percent visitors out of 269241 domestic visitors who visited Lower Subansiri (Ziro Valley). Average tourist expenditure is less in Arunachal Pradesh as a whole amounting to paid accommodation from INR350 to INR1750 per head; Travel INR 200 to INR 1250 per head, INR1800 for shopping, about INR1700 for food and drinks. (Ministry of Tourism, 2017).

Income from accommodation, souvenirs, textiles and garments are limited as there is a lack of coordination between tourism, cottage industry sector and native entrepreneurs. Limited but mid-segment hotels and Home Stay are available and have good occupancy during peak season and generate income. There are seven hotels and twenty homestay facilities available in Ziro Valley. Recently, native enthusiasts, NGOs are organizing to popularize Ziro through Music Festival with the contemporary theme “Ziro with ziro waste”. The government of Arunachal Pradesh has been promoting tourism in the state by various means including regional festivals. The resorts and tribal homestay setups get packed with tourists including foreigners during the festival days. Government offers unemployed youth and entrepreneurs to take up projects under schemes of i) Food-processing units in agriculture, horticulture, ii) Eco-tourism including homestays and tour operators, iii) Traditional textile weaving for modernization of traditional looms, iv) Small scale manufacturing units /service centres/ diagnostic centres etc. This is a significant step for developing the economy of native people. However, a holistic and coordinated approach is ideal to promote the multifunctional facet of agriculture for development.

Agriculture and Ecological Functions

Rizipisciculture as defined by FAO is a type of rice-field aquaculture: combined production of rice and fish or shrimp; alternating and/or simultaneous harvests of rice and fish or shrimps; use of the rice field for rearing. Rearing fish along with paddy is a sustainable system practiced by Apatani in Ziro Valley and they harvest paddy and fish as a unit reaping multiple benefits. Fish farming in the crop fields started in the early 1960s like

the standing water in the fields with raised bunds and controlled water outlets restrict the movement of fish from one field to another found best for dual benefits and economically rewarding. This is also taken as an additional source of food and nutrition for the native community. Besides this, Paddy cum fish increases rice production (Coche, 1967) as it acts as a catalyst for paddy yield in many ways as it helps

1. Increase in organic fertilization by fish excreta and remains of artificial feed.
2. Better tillering of the rice seedlings due to the activity of the fish.
3. Reduction in the number of harmful insects, such as paddy stem borers, whose larvae are eaten by fish.
4. Reduction in rat population due to the increase in the water level.
5. Increased mineralization of the organic matter and increased aeration of the soil resulting from the puddling of mud by benthic feeders.
6. Control of algae and weeds (by phytophagous fish) which compete with rice for light and nutrients.

Apart from its high-income value, paddy cum fish farming provides a high degree of ecological efficiency. Key ecosystem services are: provisioning services like capture fisheries, aquaculture; regulating services like nutrient cycling, pest regulation, sustain agricultural productivity, carbon sequestration, erosion regulation; cultural functions like spiritual and religious values, aesthetic values, recreation and ecotourism. In the Ziro Valley area there are about 108 indigenous plant species used in food, ethno-medicine, handicrafts, hunting and cultural practices by the Apatani tribe (Srivastava,

et.al. 2010). It is a delicate balance and has been sustained for centuries. However, its importance is in decline due to availability and growing choice of a variety of food, the introduction of modern medical and healthcare system etc.

Shackles of universal theory and incompatibility

Development initiatives are mostly driven by economics and paradigm shifts within the realm of economics. The concept of sustainable development gained prominence due to overwhelming pressure on geobiosphere resources, with the report known as Brundtland Report of WECD in 1987. "Since then the model of sustainable development has gradually become a vogue statement at the national and regional level where development perspective is generally projected through the window of cost-benefit analysis, where economics and statistics play a major role in assessing development and prescription for development plans" (Patnaik, 2013). Sustainable Development Goals, Millennium Development Goals are a further extensions of research output and programme implementation of the sustainable development concepts outlined in the Brundtland report. However, all these are spreading like fingers pointing in different directions and do not meet to clasp. Whatever the programmes designed at the national level has been found to be inappropriate in many cases and there is a requirement for a tailor-made development initiative for the mountainous State of Arunachal Pradesh. The mountain community unfairly stretch themselves to fit themselves. With the enumerated strength and uniqueness of endowments, a holistic tool to integrate economic requirements,

conserve the ecosystem and preserve the indigenous culture can be achieved through multifunctional agriculture.

Conclusion

Agriculture in the Ziro Valley, Arunachal Pradesh has multiple functions integrating social, cultural, ecological, environmental, occupational aspects of the native communities as well as a place of solace and attraction for its salubrious condition for the visitors/tourists. These capabilities, specific to the area can be scientifically and economically harnessed for the benefit of the local communities without harming the socio-cultural and environmental setup of the area. Except for annual paddy harvest with fish collection the landscape has very limited use. Looking into the need for diversification and intensification for increasing farm income especially doubling farm income by 2022, synthesis is required to understand and utilize the core competence of the native community.

The social, economic, cultural and environmental function of paddy cum fish farming can be used to bind the social fabric, showcase the rich cultural heritage and augment income by introducing additional seasonal cash crops during the current fallow period and protecting the environment from exploitation.

At present paddy cum fish farming is continuing with the participation mainly of elderly people. There is the conversion of a crop field to the built-up area. Mechanization has started; the use of pesticides and fertilizer is no more a taboo. These are a precursor to accelerated soil erosion, alteration in traditional water conservation system, soil and water contamination. If a robust action plan is prepared after evaluating

various components it will help in checking environmental degradation and augmenting rural household income.

A holistic policy while taking care of existing practices under TEK will result in long term environmental management vis-à-vis increasing rural income avenues. The target population will be benefited by utilizing their own land resources and utilizing the cultural, social and environmental function of the unique agricultural system they have inherited for generations.

References

- Barthakur, I. K. (1973). The problems of agricultural development in Arunachal Pradesh with special reference to Subansiri district. Unpublished thesis, Department of Statistics, Gauhati University. <http://ir.inflibnet.ac.in:8080/jspui/handle/10603/66281>. Accessed on 25.03.2017.
- Bjørkhaug, H., & Richards, C. A. (2008). Multifunctional agriculture in policy and practice? A comparative analysis of Norway and Australia. *Journal of rural studies*, 24(1), 98-111.
- Blackburn, S. H. (2008). *Himalayan tribal tales: Oral tradition and culture in the Apatani Valley*. Brill.
- Central Ground Water Board (2013). A Ground water information booklet Ground Water Information Booklet Lower Subansiri District, Arunachal Pradesh.
- Coche, A. G. (1967). Fish culture in rice fields a world-wide synthesis. *Hydrobiologia*, 30(1), 1-44.
- Dollo, M., Samal, P. K., Sundriyal, R. C., & Kumar, K. (2009). Environmentally sustainable traditional natural resource management and conservation in Ziro Valley,

- Arunachal Himalaya, India. *Journal of American Science*, 5(5), 41-52.
- Kala, C. P., Dollo, M., Farooquee, N. A., & Choudhury, D. C. (2008). Land-Use Management and Wet-Rice Cultivation (Jebi Aji) by the Apatani People in Arunachal Pradesh, India: Traditional Knowledge and Practices. *Outlook on Agriculture*, 37(2), 125-129.
- Lowe, P., Murdoch, J., Marsden, T., Munton, R., & Flynn, A. (1993). Regulating the new rural spaces: the uneven development of land. *Journal of rural studies*, 9(3), 205-222.
- Marsden, T. (1999). Rural futures: the consumption countryside and its regulation. *Sociologia ruralis*, 39(4), 501-526.
- Marsden, T., & Sonnino, R. (2008). Rural development and the regional state: Denying multifunctional agriculture in the UK. *Journal of Rural Studies*, 24(4), 422-431.
- Mazoyer, M., & Roudart, L. (2006). A History of World Agriculture from the Neolithic Age to the Current Crisis (London: Earthscan).
- Meybeck, M., Green, P., & Vörösmarty, C. (2001). A new typology for mountains and other relief classes. *Mountain Research and Development*, 21(1), 34-45.
- Ministry of Agriculture and farmers Welfare, GoI (2016). <http://agricoop.nic.in/sites/default/files/AR5-Lower%20Subansiri-01.07.2015.pdf>. Accessed on 08.10.2018
- Ministry of Tourism, GoI (2017) Tourism Survey for state of Arunachal Pradesh
- Mishra, A., & Mohanty, R. K. (2004). Productivity enhancement through rice–fish farming using a two-stage rainwater conservation technique. *Agricultural Water Management*, 67(2), 119-131.
- Nath, K. (2015). Production and market efficiency for inland fisheries in North East India: The empirical study of Lohit and Lower Subansiri districts of Arunachal Pradesh. *Int. J. Fish. Aq. St*, 2(5), 39-45.
- Piccinno, A. A. (2019). Terra nova, reviving Masseria Torcito through multifunctional agriculture. <http://hdl.handle.net/10589/150369>
- Patnaik, S. K. (2013). Geospatial Perspective of Assessment of Development. Understanding North-East Region of India. *Himalayan Publisher*. 176-190
- Patnaik, S. K. (2017). Land holding, land ownership and customary law governing land fragmentation in Ziro valley, Arunachal Pradesh. *Neo Geographia*, 4(2), 1-12
- Rai, S. C. (2007). Traditional ecological knowledge and community-based natural resource management in northeast India. *Journal of Mountain Science*, 4(3), 248-258.
- Randall, A. (2002). Valuing the outputs of multifunctional agriculture. *European review of agricultural economics*, 29(3), 289-307.
- Ramakrishnan, P. S. (1992). Shifting agriculture and sustainable development: an interdisciplinary study from north-eastern India. Parthenon Publishing Group.
- Reena, M., & Nani, A. (2014). Pisciculture oriented agriculture in the Ziro Valley. *Int J Sci Res Publ*, 4(4), 700-704.
- Saikia, R., Das, T., & Das, D. N. (2015). Physico-chemical qualities of water in high altitude rice fish farming system of Ziro valley, Arunachal Pradesh, India. *Journal of environmental biology*, 36(5), 1153.
- Srivastava RC, Singh RK, Mukherjee TK (2010). Indigenous biodiversity of Apatani plateau: Learning on biocultural knowledge

- of Apatani tribe of Arunachal Pradesh for sustainable livelihoods. *Indian Jour Trad Knowledge*. 9, 432-442.
- Sumelius, J. and Bäckman, S. (2008) 'Review of studies on the establishment and management of policies for multifunctionality', *International Journal of Agricultural Resources, Governance and Ecology*, Vol. 7, Nos. 4/5, pp.386–398.
- Tangjang, S., & Nair, P. R. (2015). Rice+ fish farming in homesteads: sustainable natural-resource management for subsistence in Arunachal Pradesh, India. *J Environ Sci Eng A*, 4, 545-557.
- Trainer, T. (1990). A rejection of the Brundtland Report. IFDA dossier, (77), 71-84.
- UNESCO (2014). Apatani Cultural Landscape. UNESCO » Culture » World Heritage Centre » The List » Global Strategy » Tentative Lists <https://whc.unesco.org/en/tentativelists/5893/> accessed on 14.10.2018
- University of Missouri (2015). Apatani. Database for Indigenous Cultural Evolution (DICE) <http://dice.missouri.edu/docs/sino-tibetan/Apatani.pdf> Accessed on 13.10.2018
- WCED (1987). *Our common future*, OUP
- Wilson, G. A. (2001). From productivism to post-productivism... and back again? Exploring the (un) changed natural and mental landscapes of European agriculture. *Transactions of the institute of British Geographers*, 26(1), 77-102.
- Wilson, G. A. (2007). *Multifunctional agriculture: a transition theory perspective*. Cabi.
- WorldBank (2020): Employment in agriculture (% of total employment) (modeled ILO estimate). <https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS>
- Zander, P., Groot, J.C.J., Josien, E., Karpinski, I., Knierim, A., Meyer, B., Madureira, L., Rambonilaza, M. and Rossing, W. (2008) 'Farm models and economic valuation in the context of multifunctionality: a review of approaches from France, Germany, The Netherlands and Portugal', *International Journal of Agricultural Resources, Governance and Ecology*, Vol. 7, Nos. 4–5, pp.339–360

Santanu K. Patnaik
 Department of Geography,
 Rajiv Gandhi University
 Doimukh, Arunachal Pradesh
 E-mail: santanu.patnaik@rgu.ac.in