Contribution of ‘Rice Culture’ to On-Farm Management of Diversity and Knowledge in Nepal

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Contribution of 'Rice Culture' to On-farm Management of Diversity and Knowledge in Nepal

By Deepak Rijal[1] and Gry Synnevåg[2]

Abstract

The paper analyses the ways 'Nepalese rice culture' contributes to maintaining crop landraces and knowledge. The paper discusses the importance of local practices relating to 'rice culture' as a case from three contrasting villages of Nepal. We discuss how farmers value landraces, describe ecosystems or niches and ways farmers respond if they interact. The links of this knowledge to livelihoods have been illustrated with examples. The importance is seen from a livelihood concept.

Farmers' descriptions of "ecosystem" differ from one village to another. However, farmers across villages describe ecosystems using the same functional descriptors. The primary descriptor for ecosystems is soil moisture. Farmers characterise ecosystems further against soil colour, texture, scent and sometimes with soil acidity. Sometimes indicator species are also used. Unlike farmers' ways of using larger descriptive units and scales, researchers describe ecosystems according to soil analysis data. The review shows that most of the landraces are grown under marginal and stressed environments. Improved varieties, however are grown with high level of inputs such as irrigation and fertilizers. But also some landraces are sometimes cultivated with inputs as improved varieties. Landraces are grown for generations by farmers for economical, ecological, social and religious reasons.

The paper recognises the important contribution of 'rice culture' to the conservation of crop landraces and local knowledge. Contributions are particularly important where farmers' choices and services are limited. Unlike improved varieties, landraces combined with local knowledge, provide greater societal services. The paper concludes that landraces together with modern varieties contribute to peoples' livelihoods.

Key words: Landraces, Livelihoods, Modern varieties, Nepal, Rice.

1. INTRODUCTION

Agricultural biodiversity is an important subset of "livelihood security". In the broader term, it includes all components of biological diversity of relevance to food and agriculture (UNEP, 1992). Agriculture in developing countries plays a central role in securing livelihoods by providing food, clothes and medicine. It encompasses the variety and variability of animals, plants and micro-organisms, at the genetic, species and ecosystem levels, which are necessary to

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sustain key functions of the agro-ecosystem, its structure and processes for, and in support of, food production and food security (FAO, 2000). This includes any forms of genetic resources in relation to food and agriculture including wild and cultivated varieties and **landraces.** Landraces are products selected by farmers for their various forms of production benefits (Cleveland, Soleri and Smith, 1989). A landrace is a variety bred and cultivated by farmers and adapted to local conditions. These have specific traits that satisfy specific need(s) but all components of the population are adapted to local climatic conditions, cultural practices, and disease and pests (Harlan, 1975). Unlike distinct, uniform and stabilised modern varieties with wider adaptation, landraces are considered to have a narrow range of adaptation as they were developed through natural and human selection (Salvatore and Grando, 1999 cf. Jarvis *et al*., 2000) over time.

Until the early 1960s, crop landraces were the livelihood options to farmers in developing countries since there were no modern varieties developed. UNDP (1995) estimated that nearly 20% of the world food comes from biodiversity maintained in traditional farming systems. Unlike traditional varieties, modern varieties demand high inputs and are also grown on larger scales. Many studies have shown a positive correlation between modern varieties and input levels (e.g. Kshiasagar and Pandey, 2003; Garrity, 1988). Thrupp (2000) described local and improved genetic resources to be serving people practicing micro-niches and larger ecosystems, respectively. Along with wider adoption of modern varieties, most rice landraces and much knowledge was displaced or marginalized. Until recently peoples' livelihoods have depended upon biodiversity maintained in traditional systems particularly where economic and demographic pressures for growth are very low (Thrupp, 2000). On the contrary, livelihoods of urban populations including areas with improved access to inputs, market and services are dependent on modern varieties. The knowledge associated with landraces and modern varieties are sometimes described as local and scientific knowledge, respectively (e.g. Dewalt, 1994; Talwar and Rhoads, 1998). It should not, however, mean that local knowledge is unscientific.

Despite the significant contribution of crop landraces, various myths have been created relating to world food hunger. Lappe, Collins and Rosset (1998) described 12 myths along with their responses. The myth related to food and agriculture is "low input agriculture is always low output" – landraces are part of the answer. Other myths include "landraces are always less productive" – landraces are the options, and "landraces are adapted to marginal areas"- give good yield where modern varieties even fail. Along with substance value, landraces are locally valued for their social, ritual, and religious importance. One needs food, but landraces that symbolise non-material social, cultural and religious goods should be taken as part of peoples' life. Haug (1999) states that perception of different actors (farmers-consumers, scientific communities) in viewing potential resources and means of enhancing peoples' livelihoods has not been elaborated so far.

Farmers formulate livelihood strategies based on their own knowledge and/or culturally inherited from their ancestors. In recent times, importance of landraces and peoples' knowledge is increasingly recognized, regardless of policy and economic biases towards modern varieties. There are differing views regarding modern varieties: a) they are poorly adapted to areas where traditional practices are followed, b) they demand high external inputs and improved practices, and c) they hardly provide social, cultural or religious services. Landraces on the other hand are selected for socio-cultural and food preferences. Brush (1977) reported that the most highly prized varieties are often the most delicate and least productive. Empirical evidence is lacking that shows link between crop landraces, local knowledge and their contribution to livelihoods. The specific questions addressed in this paper are: a) how does 'rice culture' relate to rice diversity; b) how do farmers select landraces in response to diverse ecosystems; and c) how do landraces and knowledge relate to peoples' livelihoods. The potential roles locally adopted 'rice culture' have been playing in securing livelihoods is examined. Myths related to local resources are examined using a livelihood concept. The paper explores rational ways for better livelihoods.

2. LIVELIHOOD APPROACH USED AS AN ANALYTICAL TOOL

Livelihoods are secure when households have secure ownership of, or access to, resources and income earning activities, including reserves and assets, to off-set risk, ease shocks, and meet contingencies" (Chambers, 1988). A livelihood comprises the capabilities, assets (capital, social) and activities required for a means of living. Conceptually, sustainable livelihood connotes the means, activities, entitlements and assets by which people make a living. Assets, in this particular context, are defined as not only natural/biological (i.e., land, water, common property resources, flora, fauna), but also social and political (i.e., community, family, social networks, participation, empowerment, human (i.e., knowledge, creation by skills), and physical (i.e., roads, markets, clinics, schools, bridges) (UNDP, 1999). In the broader context, security can be enhanced by reducing poor peoples' vulnerability to ill health, economic shocks, **crop**

failure, policy induced dislocations, **natural disasters**, and violence, as well as helping them cope with adverse shocks when they occur (World Bank, 2000/1). Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active, healthy life (FAO, 1996b: 7). There are differing views where livelihoods are defined in a range of cultural contexts. Eide *et al* (1986) conclude that the viable procurement of food must be consistent with the satisfaction of other basic material and non-material needs (Maxwell and Smith, 1992). Despite foods, livelihoods are considered secure when people are able to meet local norms and social obligations. Three distinct livelihood subsets considered here include landrace, farmers' knowledge and change brought about by local practices. Each of the subsets is described below.

3. DESCRIPTION OF RICE ECOSYSTEMS

3.1. FARMERS' WAYS OF DESCRIBING ECOSYSTEMS

Since rice culture is an age-old practice, farmers hold rich knowledge about their landraces, which is culturally transferred from generation to generation. The review suggests that the evolution of a rice ecosystem in Jumla valley dates back to the 12th century B.C., probably inspired from a large irrigation scheme of Kashmir, bordering valley in India. Despite a cool climate, low and erratic rainfall, less appropriate for crop farming, promoting rice in the mountains (>2000meters) may be termed as unique (Bishop, 1990).

Literally, the ecosystems described across villages are different. However, the descriptors used across all villages were more or less the same. Farmers describe major rice ecosystems by moisture regimes. The other key descriptors include soil colour, texture, pH and fertility status. Farmers distinguish ecosystems according to the source of irrigation water, which differs in terms of temperature (Talium) and productivity (Begnas and Kachorwa). Farmers sometimes use local species as indicators of certain niches. Farmers describe soil pH using a variety of indicators. The elaborated meaning of each descriptor is presented in Table 1.

Table 1. Farmers' knowledge of rice ecosystems of Talium, Begnas and Kachorwa sites in Nepal.

Descriptors	Location			Explanation	
	Talium	**Begnas**	**Kachorwa**	**Literal translation**	**Distinguishing characters**
Moisture	Kholapane	N.A.	N.A.	Irrigated from glacial river	Glacial source of irrigation water
	Gadkule	N.A.	N.A.	Irrigated from natural streams	Stream source of irrigation water
	N.A.	Kulokhet	N.A.	Canal irrigated plots	Permanent source of irrigation water
	N.A.	N.A.	Nicha	Located below the level of irrigation canal	Permanent source of irrigation water
	N.A.	Tarikhet	Ucha	Located above the level of irrigation canal	Rain fall as the source of irrigation water
	Ghaiya	Ghaiya	Bhith	Direct seeded rice sown on unbunded plots	Rice seed sown on uplands (unbunded rice)
	Sim	Dhav & Sim	Dhav / Maan	Swampy land	Water stagnation
Soil texture	Balaute	Gager	Bangrah	Sandy and coarse soils	Soil texture; low water retention capacity
	Chimte	Chimte	Rehayee	Clayey soil particles	Texture; high water retention capacity
	Domat	Pango miskat	Muslangarah	Sandy loam, good soils	Texture: low water retention capacity
	Lesilo	N.A.	N.A.	Silty clay	Texture; slippery
	N.A.	Dhungyan		Gravel-like	Texture; gravel
	N.A.	Balaute	Baluhawi	Sandy soil, poor water retention	Texture; low water retention capacity
Soil colour	Kalo	Kalo	N.A.	Black soil	Colour
	Phushro	Khairo	Khaira	Browny soils	Colour
	Rato	Rao	N.A.	Red soils	Colour
	N.A.	Kamere	N.A.	Whitish brown	Mixed colour
Soil reaction	N.A.	Amilo	Telbagari	Low pH	Sour or salty

Source: Focus Group Discussion (2002), Poudel, *et al*., (1999), N.A.=not applicable.

Literally, differing ecosystems described across all the villages have functional equivalences. Kholapane and Gadkule are both irrigated ecosystems, but differ in terms of the sources of water through which they are irrigated. Sinchit and Nicha both belong to the same irrigated ecosystems (Table 1). Ghaiya and Bhit are unbunded ecosystems whereas Tari and Ucha are functionally similar rainfed ecosystems all are recognized with different names locally. Sim and Dhav or Maan ecosystems are characterized with excess moisture having drainage problems. Soil texture was another descriptor widely used by farmers. Soils are characterised as coarse, fine, and loam. There are sub-categories created according to their combinations. Soil colour was another descriptor widely used. Soil colour can be a strong indicator of soil quality, texture and fertility. Red soils were reported from Begnas. Thus, the access to moisture, colour and texture are good predictors of soils productivity.

3.2. RESEARCHERS' WAYS OF DESCRIBING ECOSYSTEMS

As shown in Table 2, researchers describe ecosystems according to the availability of irrigation water. The International Rice Research Institute (IRRI) described ecosystems to include irrigated, rainfed lowland / partially irrigated and rainfed. The deepwater and tidal rice ecosystems are also recognised (IRRI, 1995). Soil samples are analysed for their physical (texture, colour) and chemical (elements, pH) properties based on which ecosystems are characterised. In line with IRRI's approach, similar rice ecosystems are described for Nepal (Gauchan, 2000). Through laboratory analysis the amount and degrees for water holding capacity, organic matter content, major soil nutrients and soil pH levels are determined. Likewise, the moisture regimes and fertility status are described as per soil analysis reports. The ways ecosystems are recognized using variable scales, units and indicators used by each community were found to be slightly different.

Table: 2 Distribution of rice ecosystems (% of country total) and modern varieties for selected countries, (1995)

Variables\ Countries	Japan	Lao PDR	Cambodia	Nepal	Philippines
Irrigated rice ecosystem	99.1	7.2	8.0	22.3	62.2
Rainfed lowland rice ecosystem	0.0	56.9	58.4	71.1	34.7
Upland rice ecosystem	0.9	35.9	1.7	3.0	03.2
Others (Undefined)	0.0	0.0	31.9	3.6	0.0
Area planted by modern varieties (Different year i.e. 1999)	100.0	2.0	11.0	36.0	89.0
Grain yield (kg/ha)	6343	2532	1715	2391	2804
Total rice area ('000ha)	1788	718	1961	1514	3978
Population ('000)	125068	4882	10024	21456	67839

(Source: www.irri.org, 2000)

3.3. CLOSENESS BETWEEN FARMERS' AND RESEARCHERS' DESCRIPTION OF ECOSYSTEMS

Farmers and researchers describe ecosystems in different ways. The researchers conceptualise and create databases and describe ecosystems using multiple parameters including moisture, fertility, and physical and chemical properties of the soils. Based on measured data researchers describe ecosystems at different scales. Throughout the Nepal Himalayas, microclimates are extremely diverse (Sthapit and Bhattarai, 1998). The amount of rainfall even within the Karnali Mountain, for example varies significantly from one location to the other (Bishop, 1990). Such micro-climatic variations definitely influence the description of ecosystems. This shows a certain degree of limitations in applying researchers' ways of describing ecosystems.

Local ecological knowledge is related to practical aspects of crop cultivation. Farmers are masters of their plots and the rice ecosystems they manage. Farmers describe ecosystems at the micro-level using a single or a combination of descriptors including indicator species or landraces. Talium farmers differentiate ecosystems by the source of irrigation water. Farmers believe that the difference in water sources has significant impacts on productivity, soil physical and chemical properties. Farmers examine soil properties using a variety of methods such as taste for pH, scent and colour for organic matter and the types of weed or specific landraces that grow over time. Begnas farmer, Mr. Surya Adhikari, views that the soil pH can be estimated by taste and by monitoring the types of weeds that grow over time.

The descriptors both farmers and researchers use were similar, but they differ in terms of their scale and applicability. Farmers' descriptors are practically measurable just as those of the researchers. Those descriptors are measured at large scales and their impacts are judged using different indicator species. Unlike farmers, researchers consider many more chemical elements to characterise soil types. Since farmers are concerned with their micro-climate and their own farm, they disregard wider applicability and generalisation. Farmers' use a few descriptors to examine chemical properties of soil. The ways both the farmers and researchers describe ecosystems were found to be very similar. However, the description of the ecosystems is influenced by localised fluctuations of rainfall and temperature coupled with local practices. Farmers provide information related to local ecological knowledge that could help determine the scientific description of the agro-ecological zones and ecosystems in particular. Clearly, farmers and researchers' descriptions have both strengths and weaknesses.

4. LOCAL USE AND BENEFITS OF RICE LANDRACES

4.1. FARMERS' PRACTICES FOR ECONOMIC YIELDS

Local practices adopted for landraces and modern varieties are discussed. Landraces such as Jhinuwa adapted to fertile ecosystems were grown in small plots because of their low yield. The size of the plots varied by agro-ecological zones. It is worth noting that on average, the plot size allocated (in ha) for landraces ranged from 0.13 in Talium to 0.36 in Begnas and for modern varieties 0.2 in Begnas to 0.7 in Kachorwa (Rana *et al.*, 1999). Cultivar diversity was the highest in Begnas, followed by Kachorwa and Talium. This diversity largely corresponded to ecosystem diversity (Table 3). In Talium only landraces were grown whereas the highest numbers were subsequently in Begnas and in Kachorwa. The number of modern varieties grown in Kachorwa was higher than in Begnas. Regardless of cultivar types, no external inputs are applied to ecosystems having high inherent fertility e.g. swamp and marshy lands. Irrespective of the sites and rice ecosystems, the average amount of chemical fertilizers used for modern varieties was higher (120 and 147 kg/ha) than for the landraces. The amount of chemical fertilisers used for landraces was also very variable. Table 2 shows that landraces are also grown with chemical fertilisers but the amount was not as high as that applied for modern varieties. It was known that farmers across all sites apply chemical fertilisers to landraces as modern varieties. In Begnas, farmers apply less fertilisers; the amounts, however, were higher in Kachorwa. With regard to greater variation of the consumption of fertilisers, the difference of productivity by cultivar types was minimal. The survey statistics show that the importance of rice and cultivar types is apparent in fulfilling peoples' needs and preferences. Modern varieties are well taken locally and are grown with high levels of inputs. According to the degree of contribution of modern varieties and landraces to livelihoods and the response of cultivars to input levels, local practices are adapted.

Table 3. Description of rice management practices across review sites, Nepal

Variable		Eco-sites		
		Talium (n=180HH)	Begnas (n=208HH)	Kachorwa (n=201HH)
Rice area (ha)	N.A.	258	363	627
Farm size (ha) / HH	N.A.	0.33	0.65	0.74
Irrigated (ha)/HH	N.A.	0.16	0.32	0.61
Average rice diversity (no.)	Landraces	21	63	33
	Modern	N.A.	06	20
Total amount of chemical fertilizers of all kind used (kg/ha/HH)	Landraces	88.6±25 (n= 14)	53.5±4.6 (n=93)	126.6± 9.3 (n=78)
	Modern	N.A.	119.7± 41 (n=65)	147.54 ±5.4 (n=192)
Productivity (t/ha)	Landraces	2.33±0.4	2.04±0.34	2.34±0.4
	Modern	N.A.	2.75±0.24	2.37±0.3

Source: Rana *et al.*, 2000, N.A.= not applicable, HH=Household

Table 3 shows that farmers' management practices differ by sites and cultivar types. The productivity of landraces (grown with a low level of management practices) against modern varieties (grown with a high level of management practices) may be worth comparing at national levels.

4.2. FARMERS' CHOICE OF LANDRACES AS LIVELIHOOD OPTIONS

Table 4 shows rice productivity corresponding to irrigation facility, chemical fertilisers used by cultivar types. Above 36 per cent of the total rice area is planted by improved varieties meaning that the remaining 64 % is covered by landraces. This area coverage was higher in the middle hills and decreased for the Tarai plain and in the mountains. In comparison to irrigated ecosystems, rice productivity under rainfed ecosystem was low (2391 kg/ha).

Table 4. Area coverage (ha) and grain yield (kg/ha) over agro- ecosystems, Nepal

Agro-ecological zones	**Ecosystem**				**Total (%)**	
	Irrigated rice (%)		Un-irrigated (%)			
	MVs	Landrace	MVs	Landrace	MVs	Landrace
Mountain	26.9	4.0	28.5	40.4	55.4	44.5
Middle hill	33.0	9.3	15.6	41.9	48.7	51.2
Tarai plain	42.0	5.8	30.6	21.4	72.6	27.3
Nepal	39.3	6.6	26.8	27.0	66.2	33.7
Productivity (Kg/ha)	2821	2228	2314	2100	2615	2125
Total area (ha)	596260	100826	40697	410157	1003227	510983

Source: ASD (1999). MV= Modern Varieties.

A similar productivity trend was evident in both cases. The analysis has raised some questions regarding the justification of continuing landraces cultivation when they are low yielding. The yield parameters encompass the levels of management practices used. Despite the facts discussed earlier, farmers' reasons for growing diverse landraces include: 1) high level of fitness characters particularly on marginal soils; 2) food preferences including post-harvest and culinary characters; 3) biomass yield useful for domestic purposes; and 4) as risk aversion option.

Farmers claim that rice grains are tastier when grown with water from natural streams compared to those grown with water supplied through irrigation canals. Along with grain yield, varieties that produce more straw are preferred. Straw qualities for feed are influenced by their biochemical content and landraces produce a range of different quality straw. Rice straw, the major agricultural by-product of South Asia, is high in lignin and silica. Both these components play an important role in reducing the digestibility of straw. The crude protein content of rice straw is generally between 3 and 5 per cent of the dry matter (Jayasuriya, 1983). Rice straw with rough texture has low fodder value, but is considered useful for other uses. Anadi, with tall and rough straw, is less palatable. However, it is preferred for making mats (Rijal, *et al.*, 2000). In rainfed Tars[3], Nepalese farmers grow rice landraces mixing with other varieties and sometimes intermixed with maize to minimise risks of crop failure. Varieties of similar maturity and grain types that demand different levels of inputs are intermixed. This system, locally called 'Kaude', is a common practice of rainfed rice. The purpose of such local practices was to a) meet household's needs (flatten rice, good eating quality, early maturity and easy threshing; and b) maintain diversity for minimizing **risk** and maximizing **food security** (LI-BIRD, 1996).

Research impact studies conducted in western Nepal show that farmers disliked many improved varieties evaluated together with farmers' varieties. Farmers' reasons include poor cooking quality and taste, high input requirements and low straw yield (LARC, 1997). The reasons for liking landraces were high straw yield, higher milling recovery, good cooking quality, and high or equally good grain yield. High straw yield was one of the most important reasons given for the continuation of landraces. Table 5 presents both strengths and weaknesses of the landraces and improved varieties.

Table 5. Reasons (number of respondents per variety) for continuing use of either modern varieties or landraces in the western hills of Nepal

Characters\Varieties	**Modern varieties**			**Landraces**
	Chhomrong	Khumal 4	Unspecified	
High straw yield	19	5	15	54
High grain yield	55	82	69	27
Good cooking quality	-	8	17	22
High milling recovery	-	-	6	22
Good taste	13	59	30	18
Straw palatability	12	7	-	17
Cold tolerance	73	-	-	13
Early maturity	-	10	17	9
Long sustaining food	10	-	-	7
Low management requirement	11	-	-	7
Lodging resistant	-	17	63	-
Good in rainfed conditions	25	-	-	-

3 Land use system that are flat typically with red and clayey soils whose productivity has been dependant on the amount and distribution of rain fall, largely farmed by marginal and resource poor cultivators.

Good for making mats	10	-	-	-
Disease resistant	8	-	-	-
Number of respondents	16	9	28	73

Source: LARC, 1997:27.

A similar response was obtained from Zimbabwe. Oosterhout (1997) reported that compared to modern maize varieties, traditional varieties were more preferred for the taste, higher grit production, being readily digestible, storability and adaptation even under drought conditions. In most cases improved varieties go along with external inputs with good management practices basically for food production. Landraces on the other hand are grown under natural conditions because they are adapted to average to marginal environments where farmers have limited options. To maintain quality of the produce, landraces are often grown without external inputs. Landraces are therefore chosen because of their ecological advantages with multiple economic implications.

4.3. LANDRACES IN PROVIDING ECOLOGICAL BENEFITS

Along with the socio-culture reasons, landraces are the choice for a variety of niches and ecosystems. To show landraces with ecological benefits different examples are discussed. Nepalese Jumli marsi, a cold tolerant rice landrace, is cultivated up to 2,740 meters. Out of several interbred varieties, it was the most preferred and widely grown landrace. In Begnas, the set of landraces is grouped according to their fitness. For example, Aanga, Mansara and Raate are landraces adapted specifically to rainfed ecosystems. Other landraces Jethobudho, Aanadi and Panhele have specific adaptation to lowland ecosystems (Table 6). However, these landraces are not cultivated reciprocally. In Kachorwa, Bhati and Silhat are landraces adapted to specific Dhav and swampy lands. Landraces Sotwa, Mutmur and Nakhisaro are typical examples from rainfed ecosystems. Landrace diversity thus is strongly linked with ecosystem diversity combined with local needs and farmers' preferences. Rhoads and Nazarea (1998) reported that farmers in a Cusco valley in Peru maintain 50 different varieties of potatoes in landscape characterised by topography, soil types, and the orientation to the sun. Their reasoning was quoted as "do not put all your eggs in one basket", which means diversity minimises risks. Growing landraces instead of modern varieties, which demand more external inputs and improved practices, can have twofold positive impacts. As indicated earlier, food items produced under traditional farming practices are tastier than those produced with high external inputs. In one way or another, growing landraces enhance the ecosystem and human health.

Table 6: Selected rice landraces with specific adaptation in different ecosystems, Nepal

AEZ / Ecosystems	Mountain (Talium)	Middle hill (Begnas)	Tarai plain (Kachorwa)
Bari (unbunded upland)	Boyodhan, Junge, Takule	Chovo, Jire ghaiya, Katuse and Kanajire, Lahare, Masino ghaiya, Bicharo ghaiya	Not reported
Kholapane	Jumli marsi (Kalo & seto marsi)	na	N.A.
Gadkule			
Ucha	N.A.	As rainfed but considered to be different	Sotwa, Mutmur, Nakhi, Aanga
Nicha	N.A.	Similar to irrigated fields	Basmati, Lajhi, Dudhisaro, Mansara, Laltangar
Tari	N.A.	Mansara, Rate, Aanga	Not applicable
Swampy or Dhav	N.A.	Lame (Samundraphinj) Aanadi, Panhele, Ekle, Jethobudho	Bhati and Silhaut
Sinchit (Irrigated rice ecosystem)	Gadkule	Ekle, Madhise, Thapachini, Gurdi, Jhinuwa	As for Nicha
Spring season	N.A.	Thapachini and traditional	Chaite and mostly modern varieties
Summer season	Single rice	All as above	As for Nicha
Adapted to shade areas	N.A.	Naltumme	N.A.

Source**:** Rijal, *et al*., (2000). N.A.: not applicable, AEZ: Agro-ecological zones.

4.4. LANDRACES IN PROVIDING SOCIO-CULTURAL BENEFITS

Farmers grow different rice varieties primarily to fulfil household needs including social norm and festivals. Farmers grow landraces for home use, guests, targeting different age groups, festive reasons and for local deities. In a small valley of Pokhara expanded to 625km² farmers grow at least 89 rice varieties. Of these, 75 are landraces. Despite the importance of diverse ecosystems in creating diversity, landraces are also associated with farmers' diverse **needs** and **preferences**. The analysis revealed that farmers maintain / select varieties for a number of purposes including home use (n=30), festival (n=19), market (n=14), guest (n=12) and for medicine (n=7). In addition, specific landraces are identified suitable for flattened rice (Chiura)**,** puffed rice (Bhujiya) and some for local recipes (n=14). Farmers consider at least 17 different selection criteria for rice varieties (Rijal, *et al*., 1998). In Kachorwa, Sathi, a landrace with closed panicle is required to worship **Goddess** *Chhati Maiya* during a festival called *Chhath*[4], celebrated locally. Farmers who do not grow these landraces have to barter with other varieties or sometimes buy from their neighbours. Because of diverse taste, farmers grow landraces for

[4] A festival celebrated by ethnic communities on the Tarai plain where *Chhati Maiya*, who is believed to be the source of inspiration of education and wealth, is worshipped.

home consumption. Rana *et al*., (2000) reported that most landraces are used for home consumption whereas the modern varieties are grown for market purposes. Brush and Taylor (1992) found that Andean farmers grow traditional potato cultivars primarily for home consumption and improved for the market. The trend generally linked to cultivar diversity. Crop landraces therefore provide services including livelihood support.

5. DISCUSSION AND IMPLICATIONS

5.1. NEPALESE RICE CULTURE OFFERS A LIVELIHOOD OPTION

The analysis shows that 'Nepalese rice culture' has provided important options to address diverse ecosystems and local needs particularly in areas that are diverse, complex and resource poor. Unlike the greater economic value for improved varieties, landraces are considered to have a variety of substance, symbolic and adaptive values. Farmers' reasons for disliking modern varieties (LARC, 1997) and farmers' selection of rice varieties that have been discarded by scientists (Mauria, 1989) for example, clearly show the strength of farmers' knowledge associated with social and ecological factors. The conventional methods of evaluating varieties where the harvest index is given greater weight is another reason for rejecting modern varieties, particularly when farmers also need crop by-products e.g. rice straw.

The complementary roles of crop landraces and knowledge becomes vital to livelihoods, particularly in areas that are diverse, complex, and which are isolated from a variety of services related to market and extension. Because of economic incentives, improved varieties are widely adopted, putting more pressure on traditional varieties. Improved varieties with a higher harvest index are cultivated for market purposes. They hardly resemble characters that are preferred by farmers as landraces. Since farmers are unbiased, modern varieties are well taken and their concerns are whether modern varieties have such preferred characters. Brush (1995) found that Andean farmers maintain traditional varieties in decreased areas. Despite these facts, the area under rice landraces is rapidly decreasing to niches or pocket areas, particularly with the adoption of modern varieties (Smale, 2000). Since the reasons for growing local and modern varieties by location and purposes vary, each type complements rather than contradicts to make a living. Farmers are therefore scientific and make rational decision that suit to local conditions. Farmers are scientific and in their scientific practice they draw upon the same cognitive structures as institution-based scientists (Amanar, 1994, Richards; 1995 cf. Kenmore, 1995).

The analysis shows that genotypes are taken provided they are: a) adapted and compatible to the given ecosystem; b) competitive with other options farmers have; c) capable enough to fulfil local needs; and d) resemble traits preferred locally.

5.2. CLOSENESS OF FARMERS' AND RESEARCHERS' ECOLOGICAL KNOWLEDGE

The ways different actors judge and describe landraces and ecological knowledge are similar, but differ in their descriptive scale and units of measurement. The knowledge produced by farmers or by researchers has both strengths and limitations. Farmers' localised knowledge has immediate practical use whereas researchers produce more specific knowledge; both are useful for effective planning processes. The knowledge produced by researchers can be used as indicative guidelines for characterisation of environments or niches at large. Farmers' knowledge is particularly applicable to describe ecosystems, soils and local practices. Other scholars (e.g.Trupp, Gauchan, 2000; Dewalt, 1994) have also shown similar ways of farmers' characterising ecosystems, environments and landraces as researchers do. Martin (1995) described various domains of folk ecological knowledge adopted by farmers while characterising local environments including ecosystems. Nepalese farmers characterise rice ecosystems and soils primarily based on the physical properties of soils (moisture, soil texture, colour) and sometimes soil reaction. The implications of such descriptions are generally seen in vegetation types, yield levels and soil properties itself. Elasticity, infiltrability or water holding capacity of soils are related to soil texture. Soil fertility was considered a product of optimum combination of these descriptors. Talwar and Rhoads' (1998) five case studies show similar descriptors used by farmers in other areas. However, farmers did not explain any descriptors relating to chemical properties of the soils. In their review, the way farmers describe soils was consistent with and matching to that of laboratory analysis. In general, Nepali farmers do not use pH as an indicator. Some trained farmers, however, claimed that soil pH can be assessed by taste and smell. This suggests that farmers' knowledge has more practical uses. Unlike a scientific approach, farmers' knowledge captures the knowledge yielded due to interactions between crop landraces and the environment.

5.3. COULD THE FOLLOWING CLAIMS BE VERIFIED OR FALSIFIED?

The reasons for verification or falsification of the following myths are discussed: a) low input agriculture always produces low outputs; b) landraces are always less productive; and c) landraces are adapted to marginal and resource poor areas.

It is worth asking how benefits associated with crop varieties are judged. Generally, the crop varieties are considered superior when they produce a high grain yield. Such myths are stated against yield potential. There seems to be a number of methodological constraints. First, the yield comparison. Performance is compared even if they are grown under variable ecosystems and management practices. Unlike modern varieties, landraces are grown with low or no external inputs, particularly under marginal soils. Modern varieties, on the other hand, are only cultivated with external inputs. Second, the valuing of crop residues must be considered. In economic terms, rice straw quality may be highly valued according to its quality. A modern variety with poor straw quality against high quality straw of a landrace definitely provides additional profits when quality straw is demanded. This applies to grain yields and grain quality, which are examined against premium prices. Third, estimation of additional input costs. The cost of grain produced for modern varieties is often disregarded while estimating benefits. These benefits are relative and are subject to change and vary from one location to another.

Tables 2 and 3 showed that modern varieties produce greater yield, but the data regarding the cost of production is unknown. The review shows that farmers consider ecological, economical and religious factors in relation to crop diversity. Such myths, we argue, can hardly be applicable under diverse, complex and risk prone areas where landraces are the options. Crop landraces with socio-religious values are grown in smaller plots even if they are adapted to good and fertile soils (Brush, 1995). Productivity may not be worth comparing when different modern varieties and landraces are grown with varying management practices. Comparatively lower grain yield reported from the Begnas was due to less use of chemical fertilisers coupled with rice ecosystem marginalities. Similar findings were reported with barley where landraces produced a greater yield when grown with low inputs plus no weed control plots, but the opposite response was apparent in the case of modern varieties (Cecarelli, 1997).

In general, both types of genetic resources as options are adopted according to how they fit local needs and preferences. Some of the myths created against landraces were **disproved**. In general, the myths underestimate peoples' perspectives on how they are integrated under wide ecological complexities. The works to establish the degree to which different crop varieties adapt when reciprocally grown across ecosystems are basically inadequate. Apparently there are methodological constraints either to create myths or to draw conclusions.

5.4. ENHANCING LIVELIHOODS THROUGH THE INTEGRATION OF FARMERS' KNOWLEDGE

Farmers and researchers' knowledge have both strengths and weaknesses. The strength is that it is generated locally and practiced locally. And it is the local farmers who rationalise its uses. The weakness is that farmers' localised knowledge can hardly be applicable to a wider context. Despite descriptive scales and units, the descriptors both farmers and researchers use were very similar, suggesting that each knowledge system is close to each other.

Evidence shows that modern varieties are grown in fertile and irrigated ecosystems, which also produce high yield. The majority of landraces are, however, grown in marginal areas. At the same time there are landraces e.g. Ekle and Jethobudho in Begnas that are grown in more fertile soils as modern varieties. In certain points, both landraces and modern varieties compete with one another. Along with the wider adoption of modern varieties, most traditional varieties and practices are marginalized. Certain groups of farmers have benefited through improved access to modern varieties and practices. The group of people adopting modern varieties has social and cultural obligations for which landraces and 'best practices' are demanded. Despite economic benefits, landraces have been playing roles to fulfil social, cultural and ritual values. Livelihoods are considered unsecure when such needs are not met, as Eide *et al*., (1986) state. Despite a high yield, modern varieties may lack some traits that are found in landraces. For this reason, landraces are highly prized for social grounds and therefore grown even if they are low yielding. In most cases, farmers' reasons for growing landraces and modern varieties were not the same. To a large extent, landraces have been the livelihood option for farmers cultivating marginal and diverse systems. On the other hand, modern varieties are primarily grown with inputs under productive ecosystems. Landraces for farmers with limited options as in marginal areas are the given livelihood options (substance, symbol and sign values) whereas the areas with more options (productive) landraces are preference options to obtained services related to socio-culture and food traditions. Here lie the differing views on landraces versus modern varieties. To make best use of local resources in strengthening livelihoods, the strengths of both knowledge systems needs to be capitalised. These livelihood strategies are subject to change in response to a change in farmers' access to information and other alternative options. The new knowledge created through farm innovations or in response to economic, social and external forces influences farmers' decision. Farmers' access to researchers' knowledge can provide useful basis to develop a responsive strategy. Mauria (1989) also indicated that local knowledge has already been in the process of integration into research systems. We conclude that integrating strengths of both knowledge systems are inevitable for sustainable livelihoods. The conceptual framework of knowledge for sustainable livelihoods is suggested (Figure 1).

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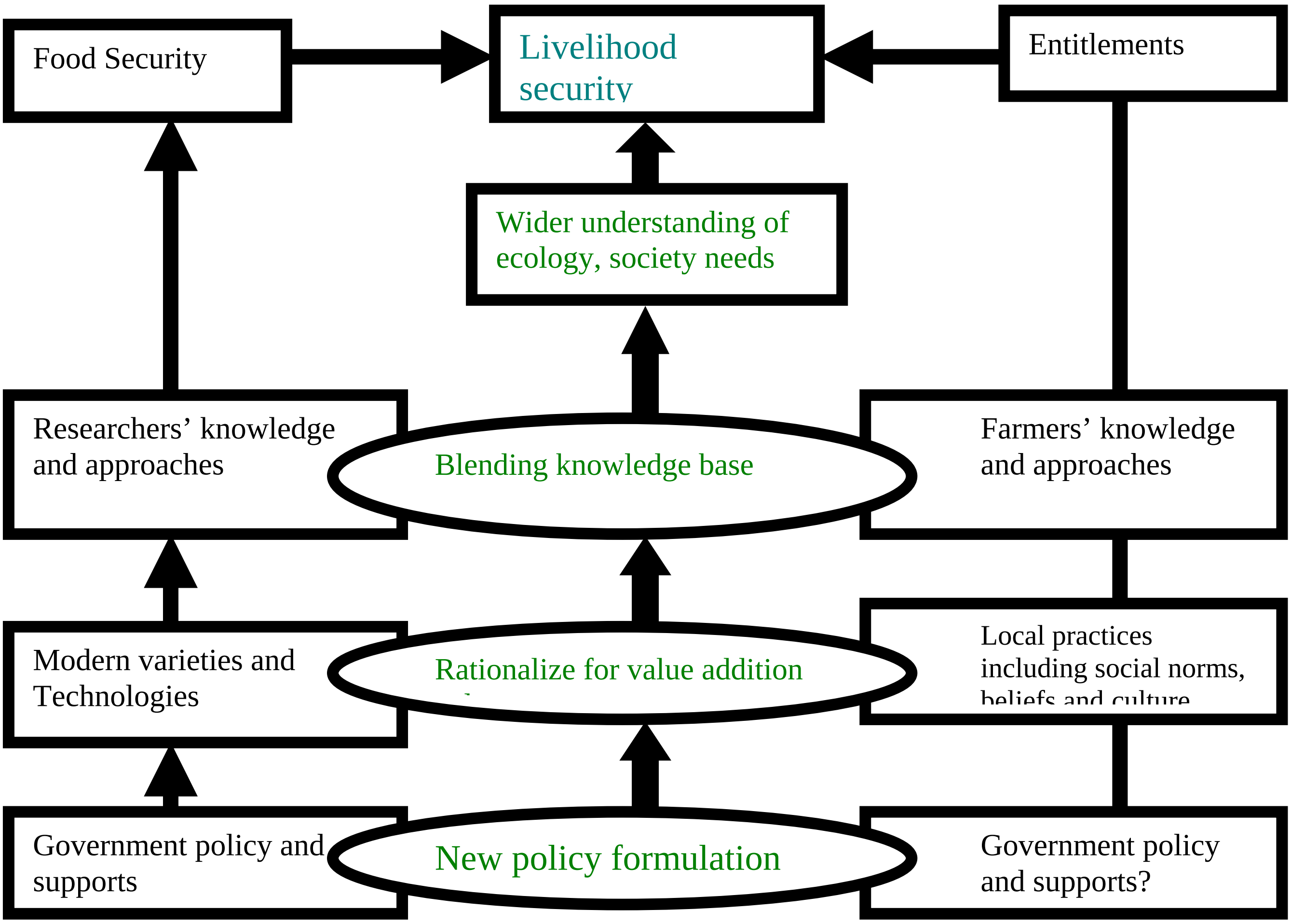

Figure 1. Blending local and scientific knowledge| for more secured livelihoods

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