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Indigenous knowledge for sustainable livelihoods: Lessons from ecological pest control and post-harvest techniques of Baduy (West Java) and Nguni (Southern Africa)

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Indigenous knowledge for sustainable livelihoods: Lessons from ecological pest control and post-harvest techniques of Baduy (West Java) and Nguni (Southern Africa)

Leeja C Korina*and Alexis Habiyaremye†

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Abstract

With the impending threat of global climate change, the last decades have witnessed an increasing recognition of the potential contribution of indigenous knowledge to tackling global challenges of environmental sustainability. The sources and wisdom of indigenous knowledge have however much more to contribute to global knowledge, well beyond environment conservation and traditional medicine. This paper uses the examples of swidden cultivation, pest control and rice preservation techniques of the Baduy in West Java (Indonesia) and comparable grain pits utilisation by Nguni tribes in Southern Africa to discuss how indigenous sources of knowledge can be an inspiration for greater social cohesion and sustainable livelihoods. It also draws lessons showing that combining indigenous knowledge systems with modern scientific methods can make it possible to achieve results that neither system can do alone.

Keywords: indigenous knowledge systems, sustainable livelihoods, Baduy community, Nguni tribes grain pits

JEL classification: O13, F64, Q15, Q57

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1 Introduction

Among mounting pressure to build a sustainable world in face of the threatening consequences of global warming, the need for eco-efficient solutions to the problems of modern production techniques is widely recognised. Whereas the lion share of efforts to deal with the concomitant challenges has been invested in scientific research to generate solutions through modern scientific and technological knowledge, there has also been a growing recognition since the 1990s among climate scientists and policymakers that much can be learned from the indigenous knowledge systems, because of their ecological orientation by the essence of their designs (Agrawal, 1995; Maila and Loubster, 2003; Rist et al., 2011; etc.). Because of its anchoring in a holistic view of culture and nature, indigenous knowledge has been perceived to possess pertinent cognitive and institutional potentials for balancing the use and conservation of natural resources. As a consequence, a growing number of scientists and policymakers have been calling for the integration of indigenous knowledge systems and modern scientific knowledge. The Convention on Biological Diversity (CBD), for example, recognised the value of traditional knowledge in protecting species, ecosystems and landscapes, and incorporated language regulating access to it and its use in its article 8 (j) in 1992. At the 2016 UN conference on climate change (COP22), this recognition was underscored by UNESCO's opening its pavilion with a special event dedicated to indigenous knowledge.

In fact, the recognition that most remaining regions of the world that are rich in biodiversity are also home to traditional and indigenous communities may hold the key to a better understanding of how to preserve the remaining world biodiversity heritage and secure sustainable livelihoods for the entire world community (Nakashima and Roué, 2002). Indeed, among indigenous societies, there is a long tradition of solving human problems by learning from other species and from the wider natural processes in which we participate. As a result, they develop a deep understanding over the course of multiple centuries, of how to live sustainably under a holistic vision underpinned by a wide array of norms, practices and values.

The role of indigenous knowledge holders in biodiversity conservation, for example, could be inferred from the observation that the rich biodiversity in their living environment, in sharp contrast with the biodiversity impoverishment that accompanies the processes of modernization and industrialization was no coincidence. Communities that have managed to preserve their traditional ways of life have also managed to maintain local ecological systems, together with the conservation, and even enhancement, of biodiversity (Nakashima and Roué, 2002). Each indigenous community with its unique world view, epistemology, values and practices contributes differently to the search for sustainable livelihoods, and as such, has lessons to teach to the rest of the humanity (Materer, Veldivia and Gilles, 2002). The aptitude and skills for the preservation of ecosystems and biodiversity among the indigenous communities are so pervasive because they are inextricably critically linked to the preservation of their own cultures that have co-evolved with these ecosystems.

In the Baduy community (Urang Kanekes), religious and social beliefs as well as the relationship to nature form the foundation of the social construction upon which their knowledge system is anchored. (Rist et al. 2011). Through their world view based on an unconditional respect for all forms of life, the Baduy indigenous people in Lebak District of Leuwidamar, Banten province of Indonesia, have developed particularly eco-efficient systems of forest conservation, plant-based pest control, and post-harvest paddy preservation techniques that can serve as a source of wisdom in dealing with challenges of building sustainable livelihoods (Iskandar, 1998; Hadi, 2006; Dhanya et al., 2013; etc.). Likewise, the Nguni tribes in southern Africa have over the course of multiple centuries developed a comparable natural method for grain conservation, which has proved to be very effective in repelling various kinds of weevils and fungi, while at the same time keeping the grains out of reach for human theft and damage by rats (Share-net, 1998). Nguni tribes comprise Zulu Xhoza Ndebele, and Swati speaking clans found predominantly in southern Africa (South Africa, Lesotho, Swaziland and Zimbabwe) but whose ethnicity are also found in Malawi, Mozambique and even Tanzania.

Both in the case of Baduy in Indonesia as with the Nguni in southern Africa, the eco-efficient methods used for pest control, medication and grain preservation are inspired by the cosmological view that connect men with nature and cosmos in general. The wisdom and skills maintained by those keepers of indigenous knowledge are based on a dynamic and sophisticated understanding of their local surroundings (Nakashima and Roué, 2002). This paper discusses the Baduy ecological rice cultivation techniques and preservation practices as well as the Nguni tribesmen grain conservation methods, as sources of demonstrable eco-efficient practices that can contribute to global knowledge stock for sustainable livelihoods. The paper is structured as follows: the next section discussed the epistemology of indigenous knowledge systems as related to their contribution to livelihoods sustainability and maintaining biodiversity. Section three describes the cultivation and post-harvest techniques used by baduy and their effectiveness in maintaining harmony with the nature and preserving the livelihoods. It also presents the comparable techniques found among the Nguni tribes in southern Africa and their proven effectiveness in preserving their harvest against pests and theft. Section four discusses the lessons that can be drawn to scale up the utilisation of these cost-effective indigenous practices for a wider awareness towards environmental protection and sustainability. The final section concludes and suggests avenues for further research.

2 Epistemology of indigenous knowledge systems and their contribution to global knowledge stock

Whenever the issue of indigenous knowledge is discussed, sooner or later the recurrent question of validity is raised (Nakashima and Roué, 2002). Scepticism arises ineluctably as the whether such knowledge is reproducible and transferable or just context specific. Critics wonder whether it is not just juxtaposition of empirical observations and obscure superstitions without distinction. Even the issue of who is indigenous and who is not is still a subject of heated debate. In his 1983 report to the United Nations (UN) Sub-Commission on Prevention of Discrimination and Protection of Minorities, the special rapporteur J. R. Martinez Cobo suggested the right of indigenous peoples themselves to define what and who is indigenous rather than being taught by others who they are and what they are not.

By design, indigenous knowledge is primarily targeted to (but not limited to) problem solving as highlighted McClure, who defines indigenous knowledge systems (IKS) as: That body of accumulated wisdom that has ..'evolved from years of experience and trial-and-error problem solving by groups of people working to meet the challenges they face in their local environments, drawing upon the resources they have at hand' (Green, 1996). Despite efforts to come to a common understanding of indigenous knowledge, there is still no unanimously accepted definition or boundaries of indigenous knowledge systems. There has been an assumption amongst academics and the public that Indigenous Knowledge is knowledge which has been almost completely annihilated and therefore, needs to be recaptured, indexed and utilised (O'Donoghue et al., 1999). Other scientists perceive Indigenous Knowledge as located in a particular source, held by the older, ordinary, uncertified men and women and traditional healers, especially in rural areas. This perception is based on the commodification of indigenous knowledge, whereby users know where to look for these indigenous commodities (Maila and Loubster, 2003).

Indigenous knowledge is generally understood as a process of social construction carried out by a community that interacts on the basis of a shared world view, that is, symbolic representations, epistemology, norms and values, and practices (Mathez-Stiefel et al., 2007). Accordingly, endogenous knowledge is generally considered to contain a potential for strengthening sustainable development processes as part of bottom-up approaches (van der Ploeg and Long 1994; Posey, 1999). For example, in South Africa, indigenous knowledge has been a cross cutting theme of the Department of Science and Technology's (DST)10-Year Innovation Plan. Reaffirming its commitment to mainstreaming indigenous knowledge in South Africa, the South African government envisages the indigenous sources of knowledge as crucial in contributing to advancing its scientific competitive advantage and stimulating sustainable economic development in the country and.

Indigenous knowledge systems are complex arrays of knowledge, know-how, practices and representations that guide members of human communities in their multiple interactions with the natural environment. It is through this fine-grained interplay between society and environment that indigenous knowledge systems have developed diverse structures and content; complexity, versatility and pragmatism; and distinctive patterns of interpretation anchored in specific worldviews. They refer to sources of knowledge embedded in the cultural traditions of indigenous or local communities. They encompass knowledge and practices related to agriculture and animal husbandry, hunting, fishing and gathering; struggles against disease, injury and accidents; naming and explaining natural phenomena, and strategies for coping with sizeable changes in their environments. They also includes types of knowledge about traditional technologies of agriculture, climate, subsistence, midwifery, ethnobotany, traditional ecological knowledge, traditional medicine, celestial navigation, ethno-astronomy, and others. These kinds of knowledge, crucial for subsistence and survival, are generally based on accumulations of empirical observation and on interaction with the living environment.

It is generally agreed that indigenous knowledge systems comprise the local sources of knowledge that is unique to a culture or society. These types of knowledge sources are also often referred to as 'traditional ecological knowledge' (TEK), 'local knowledge', 'traditional wisdom' or 'traditional science'. The International Council for Science Study Group on Science and Traditional Knowledge characterises traditional knowledge as:

"a cumulative body of knowledge, know-how, practices and representations maintained and developed by peoples with extended histories of interaction with the natural environment. These sophisticated sets of understandings, interpretations and meanings are part and parcel of a cultural complex that encompasses language, naming and classification systems, resource use practices, ritual, spirituality and

worldview".

Rist et al. (2011) prefer to refer to the notion of endogenous knowledge, as proposed by Devisch and Crossman (2002) and view it as a process of social construction carried out by a community that interacts on the basis of a shared world view, by which is meant symbolic representations, epistemology, norms and values, and practices with interesting cognitive and institutional potentials for balancing use and conservation of natural resources (Rist et al., 2011; Mathez-Stiefel et al 2007; Ellen and Harris, 1999). Devisch and Crossman (2002) proposed to consider all forms of knowledge outside the dominant "Western techno-rational scientific tradition" as endogenous knowledge, defined as:

a community-, site- and role-specific epistemology governing the structures and development of the cognitive life, values and practices shared by a particular community (often demarcated by its language) and its members, in relation to a specific life-world.

This knowledge is passed from generation to generation, usually through oral tradition, observations, practices and cultural rituals. Such systems have been the basis for agriculture and food security techniques, health care, livelihood preservation and various practices that underscore the anchoring of human societies in their natural surroundings and help sustain them in various parts of the world.

Whereas knowledge is conceived in Western cultures as an abstract entity independent from practice (e.g., science as opposed to technology), indigenous societies view such a dichotomy as alien to their interconnectedness with nature (Nakashima and Roué, 2003). Western conceptualisation of knowledge or (epistemology of science) presupposes a separation of the spiritual from the material, of religion from knowledge, and of culture from nature. Such a separation is absent in the world view of indigenous societies, whose cultures and philosophy are based on as a cosmological vision or holistic conceptualisation of humans and nature. In other words, indigenous knowledge includes not only knowledge but also know-how. Transmission is not only oral, but also in the context of doing. Finally, unlike science, indigenous knowledge does not oppose the secular to the spiritual, and therefore does not separate the empirical and objective from the sacred and intuitive. In indigenous societies, such boundaries are permeable. On the one hand, much knowledge of nature falls within the empirical realm

In the indigenous knowledge systems, the empirical knowledge is intricately interconnected with the metaphysical domain. The physical and the spiritual interact and co-evolve, complementing and enriching each other instead of competing and conflicting with one another. Because of its principal base foundation on observation and practice, traditional knowledge is highly adaptive as it co-evolves according to the changing elements of the environment. Each new generation adapts the knowledge received from the preceding generations by incorporating their own observations and transmits it to the next.

3 The Baduy (West Java) and Nguni (Southern Africa) grain preservation techniques

3.1 The Baduy and their habitat

The Baduy are members of an indigenous community of a Sundanese tribal group who call themselves *Urang Kanekes*. Their population of about 12,000 people is centred in the Kendeng Mountains in the Indonesian Banten province, where they occupy an area of approximately 52 square kilometres in the hill forest, only 120 km from Jakarta. They are believed to be the descendants of the aristocratic families of the Sunda Kingdom of Pajajaran, who refused to surrender to Islamic conquerors and fled to the mountains when the kingdom was overrun by invading Fatahillah Muslims in 1579 (Blume, 1822, Raffles, 1817). To resist foreign invasion for so long, Urang Kanekes have cultivated among their community a great wisdom related to the interconnectedness of all living things with the earth and the cosmos, as well as a thorough knowledge about the conservation and sustainability of ecosystems.

The Baduy are divided into two sub-groups: the *Baduy dalam* (inner Baduy) who maintain strict adherence to the religious prescriptions and inhabit the inner areas (where no foreigner is allowed to spend a night) and the *Baduy luar* (outer Baduy) who can have some form of limited contacts with outsiders and form the buffer between the external world and the Baduy *dalam.* There are only about 40 families of Baduy *dalam* who live in three villages in the forbidden territory (*tanah larangan*), where no outsider is allowed to spend the night. They guard the knowledge of spirituality and ritual within their community, permitting no outsider to access the sacred places or view traditional rites within their territory. The traditional chief and spiritual leader (*Pu'un*) of the Baduy comes from one of these families and the *pu'un* are the only persons allowed to have access to the most sacred ground of their religion, the *Arca Domas,* situated on *Gunung Kendeng.* Traditionally, Baduy *dalam* clan members may wear white from top to toe or with the black traditional clothing, to symbolise their purity in the strict adherence to the *Sunda Wiwitan* beliefs and practices. The remaining population is spread over the 11 Baduy *luar* villages. Baduy *luar* village members are characteristically dressed in black or dark blue, to symbolise that they have not always abided by all prescriptions of their faith and customs (*pikukuh*). They serve as intermediaries to the outside world for the more culturally "pure" members of the *dalam* clan.

Until today, they have continued to resist foreign influence and to jealously preserve the original Sundanese way of life and religious beliefs, referred to as *Agama Sunda Wiwitan.* It is from these religious convictions that they derived most of their behavioural prescriptions and their relationship to nature and environment. They are prohibited to kill any form of life, to use any form of transportation, touch silver, gold or money, drink alcohol, commit adultery or cut their hair. Those beliefs are important in preserving their livelihoods against foreign invaders. Other prohibitions include no planting of some cash crops, no breeding of big domestic animals or even cultivating wetland rice (*sawah*). They only plant *huma* rice (on dry hillside fields) and may not use chemical fertilisers.

3.2 Ecological huma rice planting process and pest control

The Baduy culture and belief system imposes the obligation on every Baduy family is to farm rice on dry fields (*ngahuma*). They are not allowed to cultivate wetland rice (*sawah*). The harvest from this farming is not to be traded: it is commonly stored in rice barns (*leuit*) for up to 50-90 years and can be inherited from one generation to their descendants (Iskandar and Ellen, 1999). *Huma* rice is mainly used for ceremonial purposes at several stages of cultivation activities, such as the cutting down of bushes ceremony (*nukuh*) to prepare the *huma* for planting, rice planting (*ngaseuk*), pest control to protect the growing rice (*ngubaran pare*), harvesting the paddy (*mipit*), and the tribute to Baduy ancestors (which are called *ngalaksa* in Baduy *luar* or *kawaludi* in Baduy *dalam*).

The rice cultivation on dry field (*huma*) among the Baduy communities is done according to predetermined periods following strict calendar based on astronomic observation each year (Iskandar, 2007). Different types of huma are cultivated at delayed time intervals to mitigate the risks of harvest loss as a result of weather or unforeseen natural hazards.

As explained by (Permana, 2010), the Baduy distinguish five types of huma, namely:

i) *huma serang*,i.e the custom fields belonging only in *Baduy Tangtu* (inner Baduy, also usually called Baduy *dalam*), i.e. the fields in Cikeusik, Cikartawana, and Cibeo villages;

ii) *huma pu'un*, which is owned by the spiritual leader (*pu'un*) as long as his holds office;

iii) *huma tangtu*, the fields for the needs of inner Baduy residents;

iv) *huma tuladan*, the fields for ceremonial purposes; and

v) *huma panamping*, common fields owned collectively by the community for population purposes of Baduy *panamping* (Baduy *luar* or outer Baduy).

Traditionally, the work of *huma* rice planting is preceded by the propitiation ceremoniesin honour of to *Dewi Sri*, the rice goddess, who is invoked to protect

Figure 1: Forest burning as a preparation to planting (source: Iskandar and Iskandar, 2016)

their land. The planting season is inaugurated by sowing (*ngaseuk*) rice seeds on *huma* serang, the ceremonial plantation reserved for the inner Baduy. Before the rice planting season, a careful preparatory process comprising the felling of tree and cutting of bushes (*nyacar*) is initiated in the Baduy calendar month of *Safar* (April-May). This is followed by the first and second burning of the cut down bushes (*ngaduruk and ngahuru*) in the Baduy calendar month of *Kanem* (June-July), which prepare the fields for receiving the paddies plants (Iskandar, 1998; 2007) see Figure 1). This burning process plays an important ecological role since a substantial proportion of the mineral energy that feeds the crops, especially the grains, comes more from burned forest ashes, so the combustion is an important factor for determining the future of the crops (Iskandar and Iskandar, 2015; see also Nakashima and Roué, 2002).

The Baduy calendar and timing of rice planting work uses observation of astronomical events, such as the position of the belt of Orion and the Pleiades, but also the flowering periods of forest trees and shrubs in *reuma* (fields in fallow),[1] as well as customary calculations (Iskandar, 1998). By looking at the position of particular stars or constellations (Orion and Pleiades), they can read the weather or the season along with the changing ecliptic, so that harvest losses due to weather changes can

[1]The changing of the seasons based on the flowering periods of the plants: the ripe of *Kanyere* fruits (*Bridelia Monoica*) for example, is used as the indicator of the coming of dry season.

be avoided or kept to a minimum (Iskandar, 2007). [2]

The first planting (*ngaseuk*) on *huma serang* is usually done in July-August (*Kapitu*), for a harvest (*dibuat*) that will take place in *Kasa* (January-February of the following year in Gregorian calendar). In addition, the planting of the *huma* belonging to the spiritual leader (*pu'un*) precedes the individual family plots belonging to the inner Baduy. Then follows the cultivation of the ceremonial fields belonging to the outer baduy and the cycle is closed by the cultivation of the common *huma*, i.e. fields belonging collectively to Baduy *luar* families. The planting on the last *huma* type in the cycle of cultivation, i.e. on community-owned *huma panamping* is generally delayed by two months with respect to the first cycle of planting (*huma serang*), and the corresponding harvest thus take place in the months of March-April. By spacing the planting periods on fields located in different places, the Baduy can avoid harvest failures due to unforeseen weather and other natural hazards (Permana, 2010). To preserve their *huma* rice from pests and rodents, the baduy always stick the stems or the branches and leaves of *Pelah besar (Goniothalamus scortechinii)* in their field at the beginning of each planting period. *Pelah* branches have a distinctive smell that serves as a repellent for rodents and insects. When the harvest processes are completed, all the land that previously used as *huma* is fallowed and can be cultivated again after three or more years. The existence of fallow periods and the burning of forest vegetation biomass in each farming period, can break the cycle of pest life or destroying rice pests and allows the soil to regenerate without the need for external fertilisers. This farming method is closely related to the concept of low external input sustainable agriculture (LEISA) (cf. Reijntjes et al., 1992).

[2]Traditional Ecological Knowledge: *Tanggal Kidang Turun Kujang* (If you have seen the Orion in the east before dawn, you should start to cut the bushes), *Kidang Nyuhun/condong ka barat kudu ngaseuk* (If the Orion is already above your head or inclined to the West, you should start to cultivate the paddy), *Kidang Marem turun Kungkang, ulah melak pare* (If the Orion is not seen anymore, you are not allowed to cultivate the paddy anymore because there will be a lot of Insect Pests called *Kungkang* or *walang sangit* [*Leptocorisa acuta*])

3.3 Sustainable soil regeneration and pest control methods

The Baduy's cosmic view, which gives precedence of spiritual life over materialism translates into their life leitmotiv that emphasises taking only from Mother Earth what is important to satisfy primary needs (Iskandar and Iskandar, 2015). This is transparent even in their farming methods, which among other things prohibits the use of chemical fertilisers, since their sustainable methods provide enough food in each planting season anew. For the Baduy, there is no need to have excessive surplus production that would justify the need for unnatural fertiliser. For their crops, the Baduy find sufficient the use of their own home-made fertilisers which are produced with organic ingredients.[3]

Soils fertility is equally achieved through the practice of fire burning which makes the minerals contained in the ashes and charcoal available for rice growth. The practice of controlled forest burning has the additional advantage of helping to manage the forest biodiversity and mitigating the risks of wild forest fire. The crucial ecological importance of this forest burning process is comparable to the practices of the fire mosaic landscapes created by the *Gagadju* aboriginals of the Northern Territory in Australia, and the swidden (slash-and-burn) cultivation practiced by the *Karen* in northern Thailand, as documented by Nakashima and Roué (2002). Because of their effectiveness in forest biodiversity management, those burning practices have now been integrated into National Park policy in certain parts of Australia through directives that explicitly call for the reinstatement of traditional Aboriginal burning regimes (Nakashima and Roué, 2002). These two case studies and similar practices in Africa point to the growing awareness today the swidden agriculture as practiced by many indigenous peoples is not only sustainable, but also contributes to other pressing global concerns including conservation of domestic and wild biodiversity, as well as carbon storage.

The practice of allocating the *huma* for other land uses, such as fallowing , also plays an important role in restoring the soil fertility. When the *huma* is fallowed and

[3] Organic fertilisers are generally made from dried leaves (koleang) and forest humus (surubuk).

becomes reuma, the Baduy usually plant it with a variety of vegetables and fruit trees such as *durian*, *kaweni*, mango, *rambutan* (*nephelium lappaceum*), bamboo, banana, coconut, and albasiah wood, whose produce can be sold on the market to increase the income of clan members (cf. Rambo, 2007). Fallowing of the *huma* also contributes to maintaining the balance of minerals and enhancing plant and fauna diversity (Nakashima and Roué, 2002; Iskandar; 2007). Indeed, the regeneration of perennial plants in the *reuma* produces useful ecosystem properties, which can lead to a better production of timber, cordwood, traditional medicines, wildlife habitat, the production of oxygen, absorption of CO2, and the conservation of various plants with soils fertilisation properties.

To control pests in their rice plantations, the Baduy consistently give preference to repelling rather than to killing. In their farming methods, they always maintain harmony with nature, rather than trying to go against nature. They therefore use biopesticides made from *rawun pare* (*Momordica charantia*) walang (*Amomum walang*), or *Kanderi (Bridelia monoica)* to repel the insects and other pests from their rice, instead of chemical pesticides considered toxic and damaging to the environment. The use of these natural, plant-based pesticides to repel rice pests has proved to be very effective as *Momordica charantia, Amomum walang and Bridelia monoica* were all scientifically demonstrated to be a midges repellent plants.

3.4 Rice conservation in *leuit* as Baduy's symbol of food autonomy

As evoked above, Baduy tribesmen are prohibited to trade their *huma* rice produce under any circumstances. They may use their surplus production of other crops and natural products to buy their basic necessities, but are never allowed to sell their rice harvest. This means that their surplus production of *huma* rice, which is mainly used for ceremonial purposes, must be stored.[4] It has to be kept in a

[4]However, in some emergency situations huma rice (pare huma) can also be consumed as a staple crop. This can occur, especially when the corresponding family does not have enough cash to buy rice from the market. Thus, as long as the Baduy have enough cash, they will buy the rice from the market for daily consumption and preserve the huma rice in their leuits for the ceremonial events and as back-up for unexpected events such as possible future harvest failure (Iskandar, 2007).

Figure 2: Rice drying and storage in leuit *with* geuleubeug *on stilts among the Baduy* luar *(source: Iskander and Iskander, 2015)*

small bamboo-walled barns called *leuit*, made from louter wooden materials (see illustration in Figure 3). Before storing the paddies in *leuit*, the Baduy put them to dry by tying and hanging them on a long bamboo pole (Figure 2).

Leuit is a kind of barn on stilts where Baduy people can keep their *huma* rice harvest unattended for a long time which can go to over 50-90 years.[5] Since Baduy's houses are made of combustible materials, the *leuit* are built separately from their houses so as to avoid accidental destruction by fire (Figures 2 and 3).

Technology to repel rats that would usually eat the rice harvest is used without an attempt to trapping or killing them. This is in line with Baduy's belief and cosmic view that nature should not be tempered with by human interference but

[5]Huma rice is usually stored in two kinds of leuit: the first is *Incu Buyut,* which is a small barn owned individually by the residents. The second is *Leuit si Jimat*, which supervise all of Incu Buyut and located near the *Imah Gede* (house of the customary leader) or *Kepala Adat* (Jaro Kasepuhan Ciptagelar Banten). Once a year, Ciptagelar holds a traditional ceremony called *Seren Taun*, as the way of expressing gratitute for the harvest. In this event, each *Incu Buyut* is expected to donnate a quantity of rice to fill the ceremonial *Leuit si Jimat* , with the amount of donated rice dependent on the ability and the willingness of the residents. The rice that is stored in *Leuit si Jimat* will only be used in case of an unpredicted emerging situations, such as harvest failure. The *huma* rice stored in the common *Leuit si Jimat* will then be distributed to the residents to fulfil their nutritional needs of rice.

Figure 3: Leuit *in a Baduy village (*kampung*)*

should be left to guide life. In their view, killing rats is thus largely considered as equivalent to destroying nature because of the potential disruption that such an act can inflict to the ecosystem and the food chain. The Baduy tribe observes thus very strict rules when it comes to protecting environment and nature.

That is the reason they have designed their *leuit* with *geuleubeug (* wooden disks), in such a way that rats are kept at bay from the rice but do not incur any risk of being killed, either by traps or predators put to that effect (see illustration in Figures 4 and 5).

Generally, the *leuit* of the Baduy are built on stilts and have approximate measurements of 1.5 x 1.5m to 2x2m. The height of their legs lies between 1 and 1.5m. Since only the Baduy *dalam* use *geuleubeug* on *leuit* legs, the other families use various aromatic leaves such as *teureup, mara , kakandelan, cariang, rane ,* and *tumbu esi* that they stick into their *leuit* as rodent repellants.

The wooden *geuleubeugs* are made quite slippery and large enough, so that the rats have no other way of climbing the leuit leg than attempting to crawl horizontally on the downside of the wooden disc. Because of the slippery property, however, no rat legs are strong enough to enable it to crawl upside down and reach the edge

Figure 4: Geuleubeug *atop a* leuit *leg (Source: Arysetywan et al. 2014)*

Figure 5: Leuit *with geuleubeug (Source: Arysetywan et al. 2014)*

of the *geuleubeug*. Even though the *leuit* are built outside the houses and are left unguarded, the Baduy community relies on the abidance of its members the moral conduct prescribed in the *pikukuh* to ward off against theft. The social cohesion and the moral discipline are so anchored in the Baduy that it would not occur to any community member to steal the rice from the unguarded *leuit*. The Baduy cultivation, pest control and rice conservation practices, by being anchored in the harmony with nature, offer therefore various advantages in enhancing sustainable livelihoods at a most affordable cost.

3.5 Grain pits for maize conservation among traditional Nguni tribes in southern Africa

The Baduy rice conservation techniques have much parallels with equivalent indigenous African gain conservation methods. For example, maize preservation techniques used traditionally by the Nguni people in South Africa share the similarities of relying on natural repellents and trust in community members to stock grain outside of the house (Leuit for Baduy and cattle kraal for the Nguni).

Nguni communities in South Africa farm maize and use an ecological conservation method to protect their harvest from weevils, rats and human theft. After harvest the maize was put to dry with the covering leaves still on the maize ears. In order to get a natural protection against insects and weevils, the maize bracteas left attached to the maize cobs would be peeled back and used to tie the maize to the rafters of the kitchen hut. The smoke from the cooking fire would, with time, create a thin film around the seeds that serves as a preservative agent and insect repellent. In order to gain an additional protection against fungi and insects, Nguni of different communities exchanged their seeds in a practice meant to ensure that dominant species of fungi and pests that favoured certain varieties of maize gain were kept in check. Seed diversity was therefore, not only a means of combining the best available seeds for better harvest, but also a proven technique of keeping putrefaction agents and predators under control.

After drying, maize grains could also be stored in grain pits dug in the ground under the cattle kraal. Such pits were between one and two meters deep and were first baked inside with a strong fire so as to eliminate the moisture and harden the surface in contact with the grains. In a well-fired pit only a small amount of maize was affected by moisture. A mixture of anthill soil and cow dung was then smeared on the pit, and left for a day or two until it was dry. The ash from the firing of the pit and cow dung prevented insects from moving from seed to seed.

After the maize grains were deposited in the so prepared pit, they were covered with grass and a rock was placed at the mouth of the pit to seal it. As a final seal, dung was smeared around it the rock. The pits were for temporal seasonal storage but the grain was sometimes kept for longer periods in times of crisis, for example, during droughts and war. Different grain was stored in different pits. The ingenuity of such preservation methods, combining the use of cattle, dung and fire was designed in such a way that in the event of rain, water could not easily penetrate the pit because the movement of the cattle compacted the kraal surface. Most water was absorbed by cow dung and extra water would run off in the spaces between the kraal poles. Keeping the maize under the cattle kraal had the additional advantage that the so stocked maize was guarded by the cattle at night. In the case an intruder tried to dig and retrieve the maize from the pit cattle would be disturbed and would bellow, and by so doing alert their owner.

The carbon dioxide fumes produced by the fermenting dung played an important role in the preservation of the grain. The carbon dioxide suffocated organisms such as weevils and rats, thereby sparing the grain from those pests. When the grain was required the cattle were driven out of the kraal in the morning, so as to get the grain. If the maize at the pit sides and entrance was spoiled it was either used for brewing or was fed to chickens and pigs. The good maize was transferred into big baskets smeared with cow dung, to be used when needed. On the basis of scientific value of cow dung in grain conservation, permaculturists are now encouraging farmers to use it for the storage of almost all grain in the home and carbon dioxide is currently playing an active role in the preservation of grain in silos.

This grain conservation method uses the same principles as the grain pits that were used to store wheat grains in Saint-Denis, France, in the 11th and 12th century (see Figure 6). To preserve the grain in an anaerobic environment the pits were filled to the top and hermetically sealed the oxygen remaining in the silo could alter the grain in contact with the earthen walls, but was quickly used up as it turned into carbon dioxide. Wheat could thus be kept for several years without fermenting and without being attacked by insects (Saint-Denis Culture, n.d.). Both the Baduy and Nguni practices give us some of many examples of indigenous knowledge with corresponding application in Western science, which is an illustration that indigenous knowledge and western sciences are part of a wider and common human knowledge stock (Agrawal, 1995).

Figure 6: Cross-section of a filled-in grain pit from the 11th century. © UASD / O. Meyer

4 Learning from both worlds: drawing lessons from indigenous practices

Even though the scientific community has only recently begun to acknowledge the significance of indigenous knowledge systems, the crucial role they play in guiding local livelihoods, food production and health care in many developing countries is widely recognised since ages. Local sources of knowledge still govern the decisions and practices of small-scale farmers throughout sub-Saharan Africa who account for more than half of the total population. According to the World Health Organisation (WHO) estimates, some 80% of the African population fulfils their primary health care needs through the use of traditional medicines (Moos et al., 2016). Both indigenous knowledge processes and scientific knowledge systems are thus crucial in addressing environmental issues and challenges faced in South Africa, Africa and the world. It has been argued in this article that these two processes of knowing can and should greatly enhance each other. If combined, they can complement each other and achieve what neither could alone (Odora-Hoppers, 2002).

While Western science is a powerful and successful methodology within its own sphere and cultural paradigm (like quantitative analysis), other valid epistemologies, such as traditional ecological knowledge systems, offer complementary approaches to understanding the natural world and our relationship to that world with which we have co-evolved since time immemorial (Maila and Loubster, 2003). Indigenous knowledge sources can help the global scientific community to tap into a rich repository of knowledge gathered over centuries of careful observation of long-term cycles. For example, the frequent use of *rawun pare* (*Momordica charantia*), which is widely known by indigenous populations around Asia as a medicine and pesticide, proves that indigenous epistemological approach has developed its independent and readily applicable solutions with no need for external validation. Rawun pare contains an array of biologically active plant chemicals including momordicin, charantin, triterpens, proteins, steroids, alkaloids, saponins, flavonoids and acids due to which this plant possesses anti-fungal, anti-bacterial, anti-parasitic, antiviral, anti-fertility, anti-tumorous, hypoglycemic and anti-carcinogenic properties (Zafar and Neerja, 1991; Grover and Yadav, 2004; Beloin et al., 2005). Agrawal and Kamal (2004) also found it useful in the treatment of cancer and diabetes. It is a potent hypoglycemic agent due to alkaloids and insulin like peptides and a mixture of steroidal sapogenins known as charantin (Gupta et al., 2011).

Regarding the use of other medicinal plants, the Baduy community have still around 60 known species of plants that they regularly resort to for the treatment of various ailments. The most frequently used are the leaves of **Aceh** (Rambutan = *Nephelium lappaceum L.*), **cecendet** (ciplukan = *Physalis peruviana L.*), **cangkudu** (noni = *Morinda citrifolia L.*), **cikur** (kencur = *Kaempferia galanga* L.), **harendong** (Senggani = *Melastoma malabathricum L.*), **jahe** (ginger = Zingiber officinale Rosc.), **Jukut Eurih** (cogon grass = *Imperata cylindrica* (L.) Beauv.), **Jukut wisa** (jarong = *Achyranthes aspera L.*), **kadaka** (sisik naga = *Drymoglossum piloselloides (L.) Presl.*), **Laja goah** (elephant = *Alpinia galanga galanga L.*) Willd.), **lame putih** (pulai = *Alstonia scholaris L.*), **lempuyang emprit** (Lempuyang pahit = *Zingiber amaricans*), **panglay** (bangle = *Zingiber purpureum*) **sirsak** (soursop= *Annona muricata L.*), and **singugu** (senggugu = *Clerodendron serrature*). For each of these plants that are widely used in healing diseases occurring among the Baduy community members, modern pharmacological studies have shown them to contain active molecules that are responsible for the observed therapeutic effects (see e.g. Dhanya et al, 2013 for *Alstonia scholaris L* and *Melastoma malabathricum* or Cassileth, 2008 for *Anona muricata*).

The relevance of integrating indigenous ways of knowing and mainstream scientific knowledge is particulary pertinent in South Africa, where the dichotomy between them has also been a tenet of the apartheid system. Explicit scorn and exclusion of indigenous knowledge and its contextual culture was an official policy until the arrival of democracy in 1994, and policies aimed at restoring the dignity of all South African citizens in line with the new constitutional vision must value traditional knowledge and give it a dignified place within the national education system. That is why e National Curriculum Statement (NCS) of the Department of Education has reaffirmed that in the South African context the recognition and value of indigenous knowledge is imperative for asserting the dignity of the great majority of people of South Africa. Such a recognition and integration of indigenous ways of knowing and cultural ways of understandings within the science curriculum has also the advantage of placing learners in a position to embrace and celebrate their identity(Hanisi, 2006).

As pointed out by Pohl et al. (2010) the experience gained from research aimed at finding more sustainable ways of managing natural resources have shown how knowledge co-production between scientists and key stakeholders is crucial. Rist et al. (2011) underscore this view by reminding that call for integrating scientific and endogenous forms of knowledge in sustainable development initiatives challenges the perception of a clear-cut boundary and division of labour between science and society, as well as the idea that science holds a monopoly over knowledge production. The debates on conceptualising co-production of knowledge have still not settled on a common way to integrate the indigenous knowledge system with the mainstream scientific knowledge. On the one side, there are proponents of using boundary organisations as independent interface to bridge the differences (Guston, 2001; Forsyth, 2004) and on the other, those who see knowledge co-production as being defined by the context, involving multiple actors with an heterogeneity of cognitive and social skills (e.g. Nowotny et al., 2001).

Rist et al. (2011) explore the way in which insights gained within relatively small groups of actors be enhanced in such a way as to promote collective learning processes in wider societal spaces when these interactions take place in the context of face-to-face communication. As suggested by Schneider et al. (2009), the enhancement of knowledge mutual learning in such circumstances may lie more in trying out new forms of collaborations aimed at social learning and co-production of knowledge rather than through institutionalised cooperation. Nonetheless, for such a social learning to take place, it is important that awareness of indigenous knowledge systems and their paradigms be broadened within the mainstream education system, so as to prepare the interface for such a collaborative learning process between indigenous knowledge depositories and modern scientific knowledge producers.

In South Africa, the call for inclusion of indigenous knowledge into mainstream education is sounding louder with each passing day. In a social attitude survey conducted in South Africa in 2009, a wide majority of respondents displayed support for the integration of indigenous knowledge into mainstream education. 76% of respondents want the department of education to include indigenous knowledge systems in the school curriculum; (65%) think that traditional healers should receive formal qualifications for their skills and 73% wanted indigenous skills to be offered at vocational training institutes, while 69% said that universities should offer degrees in indigenous knowledge systems (Moos et al., 2010). Much in line with the population attitude, the South African Government, especially through its Department of Education (DoE) and the the Department of Science and Technology (DST), has displayed a progressive attitude towards the inclusion of indigenous knowledge by according it an important role in its science policy.

As Nakashima and Roué (2002) pointed out, integration of traditional knowledge into modern science implies the application of a validation process based on scientific criteria that purportedly separates the useful from the useless, objective from subjective, indigenous useful 'science' from indigenous superstitious 'beliefs'. Such a process of cherry picking, extracting only the knowledge corresponding with the paradigm of Western science and rejecting the rest, may threaten indigenous knowledge systems with dismemberment and dispossession.

5 Summary and conclusions

In this article, we have attempted to show, through the ingenuity of the grain conservation practices of the Baduy and the Nguni tribes, that indigenous knowledge systems are potent sources of solutions to various needs of societies beyond environmental protection and traditional medicines. As illustrated by the similarity between the Nguni grain pits and the corresponding medieval wheat pits in Saint-Denis, practices in the now 'developed world' have equally evolved from traditional way of knowing, which was still predominantly applied about how to meet needs within the limits of biologically regenerative resources of the region until only 150 years ago. This means that the predominance of the recourse to modern scientific paradigm in addressing numerous challenges confronting life is only a recent phenomenon even in developed countries. By weighing the potential advantages from the wisdom that can be derived from both the scientific knowledge and indigenous wisdom it is possible include indigenous wisdom in our problem-solving toolkit alongside the best of what modern technology and science can offer as solution to the challenges we face.

A holistic knowledge framework for humanity is critical if the environmental crisis confronting us as a people is to be averted swiftly and appropriately, as pointed out by various indigenous knowledge scholars, such as Brokensha et al. (1980), Vilakazi (1999), Odora-Hoppers (2002), and Ntuli (1999). This implies, as argued by Maila and Loubster (2003), that rather than developing an ecologically coded modern society which excludes the traditions of knowing of other peoples, the world society should overcome its internal contradictions and strive for an inclusive system and process that value traditional knowledge as a precious asset holding the keys to new solutions of many of our common humanity's problems. Seen from that perspective, such in inclusive vision should be deliberately sought and vigorously developed by giving it an adequate place in the curricular education system.

Integration of traditional knowledge system with mainstream science and curricular education system implies the need for a process of co-learning and knowledge co-production between mainstream scientific communities and the masters of traditional sources of knowledge. As evidenced by the discussed cases of grain conservation, indigenous knowledge systems have much more to contribute to global knowledge stock well beyond concerns of environmental conservation and traditional medicine. That is why the process of social co-learning and co-production should explore and deepen the understanding of the following emerging issues that may contribute to fostering better dialogue and mutual complementarity:

1. Further inquiry is needed in order to extend the dialogue between modern scientific knowledge practitioners and indigenous knowledge holders in various domains such as social organisation, moral economies, or political organisation where they can complement one another (Rist et al., 2011).

2. It is still often argued that various aspects of indigenous knowledge are incompatible with modern science. Those arguments are usually rooted in an ethnocentric paradigm, whose validation norms are defined by a cultural context, yet purports to separate knowledge from culture. It would be interesting to explore new epistemological and ontological theories of knowledge validation based on a new thinking about diversity of cognition.

3. The most recurrent problematic issues of intellectual property rights with respect to traditional knowledge have been essentially about western corporations patenting technologies based on indigenous knowledge and thereby depriving the originators of this knowledge of their traditional rights to practice what they have always known and practiced. Further debate in the intellectual property right regimes should also be opened to explore how the owners of traditional knowledge sources can benefit more(beyond the existing sui generis protection) from their contribution to the global knowledge stock .

4. In the view of the above, it is also pertinent to dig deeper into the debate of integrating indigenous knowledge systems in the mainstream education curricula, where the hegemony of modern scientific epistemological system limit the ability of learners to think independently from the dominant cultural context.

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