Constructing agrarian alternatives: The case of Non-Pesticidal Management in Andhra Pradesh

Marginal farmers in South India are under severe distress (Goswami, 2009). On May 16, 2011 the government of Andhra Pradesh therefore issued an order stating that the Agricultural Department will collaborate with a semi-governmental program extension society to promote sustainable agricultural practices that "empower farmers and make agriculture remunerative." (GoAP, 2011: 1) Already since 2004, this society advocates a range of non-chemical pest management strategies for small and marginal farming communities, also known as *Non-Pesticidal Management methods* (NPM), that emerged from a small civil society project in Andhra Pradesh in the late 1980s. Therefore, the broad geographic implementation of NPM into Andhra Pradesh's agrarian policy strategy seems to speak in favour of the 'success' of the project. This article traces the historical development of the NPM project in order to look into the ways in which this was achieved.

The NPM project emerged in the late 1980s in Andhra Pradesh's Warangal district of the semi-arid region Telengana as a response to accumulating agrarian distress, when chemical pesticides did not help to counter massive pest infestations and the Red Hairy Caterpillar (RHC) in particular. Suffering high losses and simultaneously investing into expensive inputs drove many farmers into debt (Gupta, 1991; Mishra, 2006, 2009). In this context, some agricultural scientists together with NGO representatives argued that a technological innovation, which would move away from expensive, chemical-based agriculture was urgently needed. They argued for a re-evaluation of organic practices, such as farmyard manure application or composting. Drawing on already existing experiences with *Integrated Pest Management* (IPM), NPM emerged as a set of non-chemical pest management strategies while completely abstaining from chemical pesticides.[1] Building almost exclusively on locally available, non-chemical inputs, its proponents argue, NPM serves as a more sustainable agrarian alternative to chemical-based agriculture and biotechnology options.

The NPM project runs in a tradition of civilian engagement that uses the *method of creative dissent*. This method combines critiques of a particular (societal) condition, technology or mainstream policy with elements of creative and innovative. The question then is how creative dissent projects like NPM generate agrarian alternatives for development and what the particular contribution of such projects to sustainable

[1] IPM emphasizes preventive pest control strategies, such as the construction of physical barriers that inhibit pests from reaching their target plants (Hoffmann & Frodsham, 1993). Also, mechanical control mechanisms, such as sticky (yellow) boards, attract and capture particular pests. By establishing bird perches and by planting trees, predators may find a new settlement space in the habitat and stimulate the biological control of pests. Many NPM strategies are adopted and/or adapted from existing IPM experiences and thus in matters of its technological base NPM is akin to IPM. However, there is one crucial difference: While IPM allows farmers to use chemical pesticides and insecticides when pest infestation is prone to cause "unacceptable economic loss above a tolerable economic threshold." (ibid: 63) Non-Pesticidal Management prohibits the use of *any* chemical pesticide sprays. NPM, then, is more radical than Integrated Pest Management.

development may be. I argue that in order to understand how the small-scale civil society project NPM successively transformed into a large-scale policy option for agrarian development in Andhra Pradesh and how it indeed serves as an alternative to mainstream pest management practices, one has to look into *both* the material composition of NPM's methods and products and into how its proponents constructed (and then disseminated) NPM as an agrarian alternative to mainstream (bio-)technology in Andhra Pradesh. Building on ethnographic fieldwork, I first show how the project members *assembled* NPM's products and practices before I highlight how they also strategically *positioned* NPM as an agrarian alternative in the current policy discourse.

ASSEMBLING ALTERNATIVES IN THE TRADITION OF GANDHIAN CREATIVE DISSENT

The method of creative dissent combines critiques of a particular (societal) condition, technology or mainstream policy with elements of creative and innovative work. Nowadays, actors with backgrounds in science, activism and engineering use this method that combines creative work with disagreement in various institutional spaces, such as academia, research institutes and grassroots institutions (Prasad, 2001, forthcoming; Quartz, 2010; Visvanathan, 1998, forthcoming). Those who use the method are usually familiar with the thought of Mahatma Gandhi, to whom the practice of creative dissent is irrevocably connected.[2] One of his important areas of engagement was the space between science, technology and development. Gandhi's approach to science was of a non-hierarchic kind, acknowledging the relevance of different forms of knowing for the development of innovative science and technology. He was also concerned with the effects of modern science and technology on rural communities, and his critiques were always normatively oriented towards the non-obsolescence of communities (interview Visvanathan 2010). To date, Gandhian creative dissent projects tend to address the condition of marginalized or vulnerable groups.

Drawing on multiple forms of knowing

For Gandhi both science and technology are not to be separated from ethics (Gandhi, 1910). A science depleted of ethical responsibility, to Gandhi, is unacceptable, both morally and cognitively (Nandy, 1987). Morally, he refuses a non-ethical epistemology of modern science that would facilitate violence and that would render traditional communities obsolete. Cognitively, he resists the hegemonic opposition of scientific and non-scientific forms of knowing, proposing a co-existence of the two. Due to the inseparable relationship between ethics and science, Gandhi's approach to knowledge also refuses to give total autonomy to the scientific quest and he rejects an approach to

[2] While Gandhi himself did not coin 'creative dissent,' his particular method of dissent carries elements of both creative practice and dissent. Since long, Indian academics have described the empirical phenomenon of creative forms of dissent (Nandy, 1990), yet the notion of creative dissent as a concept for alternative practice was articulated only recently (Prasad, forthcoming).

science that would reduce human rationality to a narrow version of objectivity and that would define large segments of knowledge production as "irrational, romantic irrelevancies." (Nandy, 1987: 137)

But Gandhi's dissent from the hegemony of science is not just an articulation of dissent; it also includes creative tinkering. For Gandhi, modern science thus does not only reduce science to non-transcendent objectivity and 'book-based' scientific education, but also causes manual work to be considered as inferior to scientific practice. Instead, Gandhi advocates more egalitarian modes of knowledge production, which would consider different forms of expertise as relevant for development:

> We are apt to think lightly of the village crafts because we have divorced educational from manual training. Manual work has been regarded as something inferior, and owing to the wretched distortion of the Varna [caste] we came to regard spinners and weavers and carpenters and shoe-makers as belonging to the inferior castes and the proletariat. We have had no Comptons and Hargreaves because of this vicious system of considering the crafts as something inferior divorced from the skilled.[3] If they had been regarded as callings having an independent status of their own equal to the status that learning enjoyed, we should have had great inventors from among our craftsmen. (Gandhi, *Collected Works*, Vol. 66, in Prasad 2001: 3729)

Gandhi feels that the devaluation of craft contributed to India's restricted development of skills and knowledge associated with engineering and innovation and he therefore proposes to re-appreciate manual work as a vital contribution to innovation.

Gandhi's reflection on the hierarchical order of science found its relatives within a broad tradition of dissenters who criticize the dominant position of scientific knowledge in India.[4] Following this tradition of thought, creative dissent projects usually draw on the expertise of scientists, non-academic actors, NGOs, activists and practitioners alike, and the NPM project is no exception. It emerged as a collaborative effort amongst agricultural scientists, NGO representatives and farmers to cope with the problem of pest infestation. Exemplarily, I draw on the case of bonfires to illustrate this.[5]

Traditionally, farmers in the Warangal region of Andhra Pradesh used bonfires to attract and kill moths at the onset of the monsoon rains. In conversations with old farmers in the Telengana region one of the project's scientists "discovered that there was indigenous knowledge about the caterpillar at moth stage, that they were attracted to light. There were some hear-says and bonfires were traditionally used to attract moths." (interview Sanghi 2008) The respondent found that farmers ignited bonfires at the onset of the monsoon rains.[6] After conversations with an experienced volunteer from

[3] Samuel Compton was the inventor of the spinning mule (1779), James Hargreaves the inventor of the spinning jenny (1764).
[4] For example, the *Neo-vitalist tradition* of dissent attaches much relevance to an egalitarian approach to knowledge production. Patrick Geddes, town planner, biologist and sociologist, argues that a re-arrangement of existing egalitarian university-based knowledge systems should recognize the relevance of and dialogue with knowledges of a different kind, which would include both non-scientific agrarian expertise and the dissenting academies (Visvanathan, 2001, forthcoming).
[5] For a more detailed account of NPM's history of non-hierarchical knowledge production the reader might consult (Quartz, 2011).
[6] All interviewees consented with the recording, the transcription and the use of the conversations, some on the basis of warranting their anonymity (abbreviated as *Ai*).

Maharashtra and consultation with an entomologist working in another district in Andhra Pradesh (Rajan, 1994), the concerned scientist realized that in order to create impact through bonfires, collective and time-specific group action would be needed. Thus, the evaluation and refinement of bonfire strategies together with farmers was envisioned: In the early phase of the project old rubber tires fueled the bonfires. These were ignited right after the first monsoon rains fell, just as farmers had traditionally done it. However, some farmers observed that moths did not necessarily emerge immediately after the first rains fell (interview Qayum 2007). Building on these observations, the scientists reckoned that the emergence of the caterpillar moths might relate to the respective levels of rainfall. Consequently the scientists together with the farmers started to study the relationship between rainfall levels and moth emergence from some 30 marginal farming villages by help of installing rain gauges. The data collection showed that moths only emerged from hibernation when the rain levels rose above 25 mm (ibid.).

The case of bonfires shows how traditional knowledge together with scientific practice led to farmer-scientist innovations in the NPM project. This appreciation of the expertise of both agricultural scientists and farmers is rooted in the Gandhian tradition of thought and generated a very particular set of technological inventions and innovations that build on different kinds of expertise and experimenting.

Appropriate technologies for marginal communities

Gandhi's stand on technology is critical of modern technology. In *Hind Swaraj* he writes with respect to 'machinery':

> It is machinery that has impoverished India. It is difficult to measure the harm that Manchester [i.e. the spinning mill industry] has done to us. It is due to Manchester that Indian handicraft has all but disappeared. The workers in the Bombay mills have become slaves. The condition of the women working in the mills is shocking. When there were no mills, these women were not starving. (Gandhi, 1910)

Gandhi's criticism of modern technology is fundamental. He argues that technologies that introduce undesirable social change to rural communities in the name of progress should be considered as morally inferior (Nandy 1987: 136). Gandhi's critique of technology is normative and starts from the assumption that sustainment of rural communities is both ethically desirable and socially demanding. Conversely, he proposes to exclusively consider technologies as relevant and desirable that support village-based economies, i.e., that retain the relevance of villages as self-reliant units of production. In this context, Gandhi prefers technologies that function on the basis of locally available, cheap resources and that consider particular local forms of expertise and knowing. Technology that is ethically sound, Gandhi claims, has to be developed in accordance with a theory of the survival of the community (interview Visvanathan 2010).

Conversely, those technologies that allow for the community's survival and do not obstruct the continuation of traditional communities are desirable to Gandhi.

In line with Gandhi's approach to community-based technologies, many creative dissenters in India started to criticize the inappropriateness of modern technology and advocated the development of technologies that build on locally available resources. For example, the Intermediary Technology movement advocates the development of need-based and locally appropriate technologies for resource-poor communities.[7] Also NPM runs in this tradition and focused on the development of locally appropriate technologies for resource poor farmers as I show next.

When the Red Hairy Caterpillar (RHC) devastated farmlands repeatedly, the NPM scientists identified the vulnerable economic conditions of marginal farming communities as their main target. They decided to promote cheap pest management strategies that build on locally available resources, most of which emerged in accordance with the lifecycles of crucial pests.[8] For example the Red Hairy Caterpillar's lifecycle moves from egg to larvae into a hibernating pupa and finally into a moth that again lays eggs. While the RHC hibernates for more than 10 months in the soil, the first heavy monsoon rains in the beginning of June trigger the moth to come out. Moths then lay batches of eggs on plants and soon thereafter the RHC caterpillars infest and devastate crops (see figure 1).

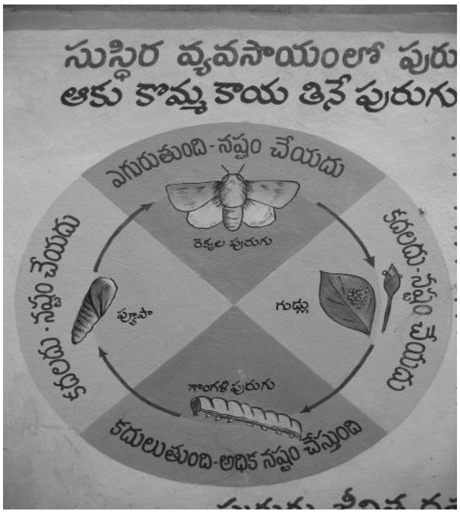

Figure 1: A Caterpillar Pest Lifecycle

Experiences in IPM had already highlighted that ploughing the soils deeply during the hot Indian summer months exposes and kills the hibernating RHC pupa when the pest hibernates during summer (Rama Rao, Srinivas Rao, Srinivas, & Ramakrishna, 2007).

[7] For further review, see cf. (Schumacher, 1973), and for a critical review, see, for example, (Willoughby, 1990).

[8] For example one tested and evaluated the effects of various derivatives of the Neem tree for non-chemical pest management and re-introduced pest repellents that build on cow waste Traditionally in India. The Neem tree's components serve as input for non-chemical contraceptives, for the treatment of (skin) diseases and for dental care. Also, the tree's seeds, leafs and oil are potent pest repellents. The pest repellent Pancha Gavya is an old ayurvedic recipe that builds on five cow products.

NPM adopted this strategy. Also, NPM farmers found that the migrating caterpillars, which have the ability to move quickly across long distances and devastate field after field, were also attracted to calotropis, a flowering and milky-sap producing plant. Therefore, the project scientists proposed to place calotropis twigs around the castor fields, which might distract the migrating RHC larvae from the crops (Ramanjaneyulu, Kuruganti, Hussain, & Venumadhev, 2004). Slowly, one developed a set of cheap and non-chemical pest management strategies that targeted the Red Hairy Caterpillar at different stages in its lifecycle.

Like in the case of the RHC, the creative dissent project NPM generated many cheap, non-chemical technologies for (agrarian) development. This process of assembling of NPM is in line with the Gandhian demand for local, village-based industries that aim at the sustainment of marginalized communities, and the Gandhian philosophy of sustainable development thus decisively influenced on the material shape of the agrarian alternative NPM. Yet, in order to understand the large-scale extension of the NPM project, I argue, one has to move beyond the materiality of it and consider how project members *positioned* NPM as an agrarian alternative, too.

Positioning Alternatives: Activist Creative Dissent as a means for Project Extension

To date, the Indian approach to the governance of agrarian development can to a large extent be characterized as non-participatory and almost exclusively based on scientific expertise, with a strong tendency to objectify scientific uncertainty (Quartz, 2011). Also, agrarian policy makers tend to rely on established scientific institutions as credible generators of relevant knowledge for sustainable development (ibid.). Thus, in order to make NPM relevant for agrarian policymakers, it was important to increase the credibility and trustworthiness of the NPM methods, and the NPM scientists started to generate scientifically credible and standardized NPM packages. Simultaneously, activist dissent from (mainly national) governmental science and technology was pursued with particular emphasis on genetically modified cotton. Together, the cooperation with governmental agents *and* the activist articulation of dissent were essential features of the project extension process, where NPM was constructed as an agrarian alternative to existing agrarian technology options.

Adaptation through scientification and standardization

When policymakers attach credibility exclusively to scientific institutions, this excludes non-scientific expertise from becoming credible for sustainable agrarian development policies. The NPM staff argued that unless one would stress the scientific orientation of their work, NPM would not manage to become a credible and hence relevant source of national agrarian policymaking processes (interview Ramanjaneyulu 2008). Thus, by identifying the policymakers' bias towards scientific knowledge, one also identified one important area of work: NPM had to *scientize* if it wanted to be transformed into a policy-relevant form of knowing for sustainable development.[9]

After some experiences with NPM in small villages in Andhra Pradesh seemed to demonstrate that NPM worked well (Joshi, 2004; Rao, 2004; Sharma, 2005a, 2005b), the NPM project was integrated into a Hyderabad-based NGO. Here, the board of trustees decided to combine "modern science with the skills and ingenuity of local people and communities" (CSA, 2008). To date, the NGO understands itself as scientifically oriented, and the majority of employees hold a degree in agricultural sciences, extension science or plant biology. Apart from its scientific personnel, the scientific orientation also began to play a role in the development of NPM's methods. A case in point is again the *pest lifecycle*. The lifecycles of various pests are essential elements of the curricula of agricultural science departments around the world (McEvoy & Coombs, 1999; Waage, Hassell, & Godfray, 1985). Linking the pest lifecycle and its accepted status as scientific knowledge to NPM was an intentional move to stress the scientific orientation of NPM's methods (interview Ramanjaneyulu 2008). In sum, both the setup of the NGO and the methods of inquiry were important means to demonstrate the scientific outlook of NPM.

However, the scientification of NPM was not enough to make the non-chemical pest management practices relevant for agrarian policymakers. During interviewing, many concerned policymakers pointed out that, in order to be relevant for agrarian policy, NPM first had to move beyond small experiences and above all prove that the methods could be copied and reproduced on a broad geographic scale (interviews Reddy 2008, Warrier 2008, Ai 1 2008, Natesh 2008). It had to be established that NPM could be transformed into a *standardized* practice.

In its initial years, NPM was a heterogeneously organized and locally multiple practice, where farmers developed and used village-specific NPM methods that emerged out of particular local constraints and resources. Notwithstanding this local diversity, the proponents of NPM began to mainstream NPM practices in replicable packages as of the late 1990s. This process slowly generated crop-specific work packages for cotton, pigeon pea, castor and groundnuts, where detailed manuals explained how the particular crops were treated best (CWS, 1998, 2000, 2001, 2002). Since 2004, the agricultural scientists also started to invest in the development of guidelines of Non-Pesticidal Management strategies for various food and cash crops. Successively, NPM transformed into a set of standardized manuals for particular crops, pests, mixtures and practices. NPM thus began to meet with one of the policymakers' prerequisites for credible knowledge for sustainable agrarian development: the project developed a degree of standardization.

[9] Scientification describes the influence of scientific methods and principles on non-scientific matter (Hard, 1994; Levidow, Murphy, & Carr, 2007). However, the notion of scientification is an analytical unit here that was not explicitly used by actors of the NPM project. It also deserves mentioning that the mapping of the scientification of NPM does not mean that I differentiate between a non-scientific and a scientific period in the project.

Both the scientification and the standardization of NPM have to be understood as means to *adapt* NPM to the demands of policymakers and thus as strategies to transform NPM into a relevant development option for agrarian policymakers. However, and simultaneously, the NPM crew worked towards the destabilization of governmental technoscientific choices. Here, dissent with modern science and technology was articulated, mainly by means of opposition to genetically modified cotton, so-called *Bt cotton*, as the next section will highlight.[10]

Destabilization through activism

Since its foundation in 2004, the NGO pursued activist dissent with Bt cotton by diverging means, the categorization of Bt cotton as a scientifically uncertain practice being one example.

The scientific uncertainty of GM crops is contested globally.[11] Many agrarian policymakers in India characterized GM crops as *simple risk situations*, which are not characterized by overall safety but where most of the possibly occurring impacts and their probability are known (Renn, 2005). In simple risk situations, there is only limited evidence that there might be detrimental impacts for humans and the ecosystem (ibid.). In such situations scientific routines and testing, such as quantifiable risk-benefit analyses, are assumed to reduce and contain risks (ibid.). By contrast, in *uncertain risk situations* the impact of a particular technology on human health and the ecosystem is uncertain and there is some scientific evidence that the innovation in question might indeed be harmful (ibid.).[12] Uncertain risk situations with their possibly harmful impact are *not* straightforwardly calculable and hence also not subject to scientific testing only. International policy formulations and research that focuses on the governance of science and technology in modern societies propose that uncertain risk situations demand prudent technology policy that follows a precautionary approach (Renn, 2005; van Asselt & Vos, 2006). And while softer versions of a precautionary approach advocate that scientific uncertainty should not preclude careful and reasonable research on the potentially harmful effects of particular technology options, a stronger interpretation holds that prohibitive regulation is required when humans and the environment are

[10] Bt cotton derives its name from the soil bacterium *Bacillus Thuringiensis* (Bt), which produces a crystal protein (Cry 1 AC) that is toxic to the digestive system of lepidopteron insects such as the cotton bollworm. In the case of genetically engineered plants, the genetic code for the crystal protein is introduced into host plants by means of genetic manipulation where it serves as an inbuilt pesticide.

[11] Some international laboratory studies propose that genetic transfer produces scientifically uncertain dynamics in host organisms (Ermakova, 2007; Ewen & Puzstai, 1999). By contrast, many proponents of genetically modified crops argue that the development and cultivation of genetically modified (cotton) crops rather relates to predictable risks than uncertain technological production (Poppy, 2000).

[12] For example, the NGO considers the 'cut-paste' strategy of genetic engineering, where gene expression in host cells is a process that is part of complex environmental interactions and that is not completely understood by scientists, as a practice that generates uncertainties with regard to the impacts of GMOs (Kuruganti & Ramanjaneyulu, 2007).

exposed to uncertain risks.[13] In its strongest definition a complete technology ban could be proposed until certainty about a technology's impact would be achieved.

The NPM proponents (along with many other contesters in science and civil society) depicted GM crops cultivation as uncertain practice. This has important consequences: making a case of uncertain risks allowed the NGO to argue for a strong interpretation of the precautionary principle, where a ban on GM crops was called for until evidence would be available about the technological safety and socio-cultural benefit of the technology (interview Kuruganti 2010). Characterizing GM crops as uncertain established an important discursive ground to critique the agrarian policy strategy that would allow for such scientifically uncertain technologies.[14]

Next to these discursive strategies, one also began to *enact* dissent with genetically modified cotton. When the NGO argued that the higher price of the Bt cottonseeds together with the expenses for chemical inputs and the overall risks of cotton cultivation increased the vulnerable economic condition of resource-poor farmers (interview Kuruganti 2007), and after one proposed that the decreasing availability of non-Bt cottonseeds on Andhra Pradesh's agricultural market would reduce the farmers' possibilities of choosing for locally appropriate seeds (ibid.),[15] the NGO scientists, by mutual consent, decided to exclude Bt cotton farmers from the NPM program (interview Ramajaneyulu 2008). Also, the project generated a multitude of written accounts that contrast Bt cotton as a non-sustainable alternative to NPM. For example *The story of Bt cotton in Andhra Pradesh (CSA, 2005)* integrates several years of experiences with Bt cotton in Andhra Pradesh and argues that "Bt cotton was introduced by conveniently ignoring safer and better alternatives that exist in this country" (CSA, 2005c: 33). The report concludes that in "this scenario of erratic Bt cotton proliferation" the government should "look seriously at its pest management paradigm and at successful, sustainable alternatives" (CSA 2005: 37). Systematically, then, the NGO constructed NPM and Bt cotton as opposite practices for and against sustainable agriculture (Quartz, 2011).

Epistemologically relevant knowledge has to offer suitable answers to a particular problem (Bijker, 1995; Mourik, 2004). Epistemologically irrelevant knowledge may then be construed if one can demonstrate that a particular technological choice does not contribute to the problem's solution, and above we have witnessed how the NGO tried to deconstruct one of the policymakers' technology solutions as irrelevant by defining

13 For an overview of the development of the precautionary principle, its varying interpretations and field-related case studies, see (Harremoës, et al., 2002; O'Riordan & Cameron, 1994).

14 Certainly, the NGO was not the only one that used the issue of scientific uncertainty to stress the unpredictability and therefore the undesirability of GM crops. Uncertainty has become a "wild card" that can tremendously undermine effectiveness and confidence in regulatory capacity (Jasanoff & Wynne, 1998). Taking the case of Greenpeace, De Wilde and others show how uncertainty politics helped many NGOs to substantiate their opposition to genetically modified crops by means of radically questioning the factual benefits of GM crops (2003).

15 According to the NGO, farmers no longer chose seeds that were tested in their fields and that had demonstrated their robustness. Rather, they started to follow seed dealers' advice, after the agricultural extension systems in India's rural areas diminished both the extent and the quality of their advisory services. This would imply that farmers cultivate seeds that are profitable to the dealer but not always beneficial to the farmer.

GM crop technologies as inherently uncertain technologies. At the NGO, dissent was of an increasingly activist character, where alternative expertise and mainstream science were juxtaposed in a categorical fashion. In the case of cotton cultivation, Bt cotton and NPM started to travel together through the CSA's narratives as opposite strategies for, respectively, unsustainable and sustainable agrarian development.

The debate on genetically modified cotton, then, served not only as a means to dissent with current agrarian biotechnology options, also it was an important means to establish NPM as a safe alternative to Bt cotton: NPM. Together, the construction of NPM as a scientifically credible and standardized agrarian alternative and the activist deconstruction of mainstream agrarian options as unsustainable were complementary efforts to *position* the agrarian alternative NPM into the policymaking realm.

Conclusion

By 2011, NPM was integrated into Andhra Pradesh's official agrarian development strategy and NPM's wide-scale adoption seems to support that farmers, NGOs and policy makers alike recognize the value of the cheap, non-chemical pest management methods. This article departed from the question of how creative dissent projects like NPM generate alternatives for agrarian development and how NPM managed to become a success with regard to its wide-scale extension in Andhra Pradesh.

Above, I have highlighted how the NPM scientists, in the early days of the project, *assembled* NPM. Drawing on both farmers' knowledge and scientific expertise one developed NPM in the Gandhian tradition of village-based industries. As a result, NPM's main features are its tailor-made pest management strategies for marginal farmers that are cheap and that build on locally-available, non-chemical inputs. I have also highlighted how NPM was strategically *positioned* as an agrarian alternative in the current policy discourse, when the NGO refined the alternative practices by means of standardization and scientification *and* when one pursued activist dissent by constructing NPM and Bt cotton as sustainable and unsustainable opposites for development respectively. The separation of creative work and activist dissent were complementary efforts to deconstruct the overall relevance of the governmental agrarian policy and to display NPM as an alternative to mainstream pest management technologies - and thus an important strategic tool to position NPM in policy dialogues for agrarian development.

Therefore, in order to understand how the small civil society project NPM successively transformed into a large-scale policy strategy for agrarian development in Andhra Pradesh, one has to consider *both* the material composition of NPM and the NGO politics that helped to construct and disseminate NPM as an agrarian alternative to mainstream (bio-)technology. NPM's "success" of extension was as much a product of careful positioning and negotiation as it was a set of non-chemical, standardized pest management strategies. Extension work is construction work, which in the case of NPM builds on the Gandhian innovation strategy of creative dissent.

Social scientists argue that creative dissent projects are important facilitators for knowledge dialogues among policymakers, researchers, farmers and civil society (Prasad, forthcoming). And indeed, the NPM project is to a large extent oriented towards dialogue with policymakers when generating pest management technologies that are scientific enough to be credible and standardized enough to be extended beyond local experiments. Creative dissent projects like NPM that focus on dialogue for development then serve as innovation strategies that build on various forms of expertise for marginal communities. However, the simultaneous effort to destabilize governmental technoscientific choices - and modern biotechnology options in particular - was counter-intuitive to dialogue at times. The decision to exclude Bt cotton farmers from the benefits of the NPM was contested, and many agricultural scientists and policymakers instead advocated Bt cotton and non-chemical pest management as two complementary methods of Integrated Pest Management (interviews Bhatia, Ai 1, Ai 2 2008). Also, the exclusion of Bt cotton farmers implied that these would not be able to benefit from the NPM methods' cheap and non-chemical pest management options. Exclusionary activist dissent reduces the multiplicity of options for sustainable development for marginal farmers. The strategy of pursuing activist creative dissent, then, maneuvered the NGO into a situation where its credibility and dialogue-ability was at risk. Thus, while dialogic creative dissent seem to be a useful innovation tool to construct agrarian alternatives, activist forms of creative dissent also generate vulnerable conditions for both farmers and an NGOs dialogue-ability.

List of Interviewees:

NAME	FUNCTION	DATE/LOCATION
Ai 1	Former co-chair GEAC, former head Institute for Cotton Research, Nagpur	29.02.2008, New Delhi English
Ai 2	Senior advisor DBT	26.02.2008, New Delhi English
Bhatia, Dr. C.R.	Former secretary of the Department of Biotechnology, Government of India	23.02.2008, Mumbai English
Kuruganti, K.	Former action campaigner at Centre for Sustainable Agriculture	3.06.2010, Maastricht English
Natesh, Dr. S.	Senior advisor for the Department of Biotechnology, Government of India	26.02.2008, New Delhi English
Qayum, Dr. A.	Agronomist and senior advisor to Deccan Development Society	12.04.2007, Hyderabad English
Ramanjaneyulu, Dr. G.V.	Executive director Centre for Sustainable Agriculture	14.02.2008, Hyderabad English
Reddy, R.	Agricultural Minister Andhra Pradesh	28.03.2008, Hyderabad English
Sanghi, Dr. N.K.	Co-founder NPM project, senior advisor to WASSAN	15.04.2008, Hyderabad English
Visvanathan, Dr. S.	Anthropologist, Dhirubhai Ambani Institute of Information and Communication Technology	28.06.2010, Maastricht English
Warrier, Dr. R.	Member secretary DBT	05.03.2008, New Delhi English

References:

Bijker, W. E. (1995). *Of Bicycles, Bakelites, and Bulbs. Toward a Theory of Sociotechnical Change*. Cambridge: MIT Press.

CSA (2005). *The Story of Bt Cotton in Andhra Pradesh: Erratic Processes and Results*. Secunderabad: Centre for Sustainable Agriculture.

CSA (2008). About CSA Retrieved 11.11.2008, from http://www.csa-india.org/aboutus.htm

CWS (1998). *Recommendations of the national workshop on non-pesticidal approach to pest management. A new direction.* Paper presented at the National Workshop on Non-Pesticidal Management 1994, Hyderabad, NAARM Rajendrannagar.

CWS (2000). *Non-pesticidal Management of Cotton, Pigeonpea and Groundnut Pests. Progress Report 1999-2000*. Secunderabad: Centre for World Solidarity.

CWS (2001). *NPM in Cotton, Pigeonpea and Groundnut. Progress Report 2000-2001*. Secunderabad: Centre for World Solidarity.

CWS (2002). *Non-pesticidal Management of Cotton, Pigeonpea, and Groundnut. Progress Report 2000-2001*. Secunderabad: Centre for World Solidarity.

de Wilde, R., Vermeulen, N., & Reithler, M. (2003). *Bezeten van Genen. Een Essay over de Innovatieoorlog rondom Genetisch Modificeerd Voedsel*. The Hague: Wetenschappelijke Raad Voor Het Regeringsbeleid.

Ermakova, I. (2007). GM soybeans—revisiting a controversial format. *Nature Biotechnology, 25*(12), 1351-1354.

Ewen, S. W., & Puzstai, A. (1999). Effect of diets containing genetically modified potatoes expressing Galanthus nivalis lectin on rat small intestine. *Lancet, 354*, 1353-1354.

Gandhi, M. K. (1910). Hind Swaraj or Indian Home Rule. Retrieved 10.07.2010: http://www.mkgandhi.org/swarajya/coverpage.htm

GoAP (2011). *Note dated 31.3.2011 on the formulation of a new society under the Societies Act for Community Managed sustainable Agriculture initiative.* from http://www.indiaenvironmentportal.org.in/content/note-principal-secretary-government-rd-panchayat-raj-rural-development-govt-ap-hyderabad-for.

Goswami, B. (2009). The Problem. Special issue on agrarian transitions. *Seminar, 595*, 1-7.

Gupta, A. K. (1991). *Building upon peoples' ecological knowledge: framework for studying culturally embedded CPR institutions*. Paper presented at the Second Annual Conference of the International Association for the Study of Common Property.

Hard, M. (1994). *Machines Are Frozen Spirit: The Scientification of Refrigeration and Brewing in the 19th Century - A Weberian Interpretation*. Frankfurt: Campus.

Harremoës, P., Gee, D., MacGarvin, M., Stirling, A., Keys, J., Wynne, B., et al. (Eds.). (2002). *The Precautionary Principle in the 20th Century*. London: Earthscan.

Hoffmann, M. P., & Frodsham, A. C. (1993). *Natural Enemies of Vegetable Insect Pests*. Ithaca: Cornell University.

Jasanoff, S., & Wynne, B. (1998). Science and decisionmaking. In S. Rayner & E. L. Malone (Eds.), *Human Choice and Climate Change. Volume 1*. Washington: Battelle Press.

Joshi, S. (2004). Village Punukula is different. *Down to Earth, 13*(2), 17-24.

Kuruganti, K., & Ramanjaneyulu, G. V. (2007). *Genetic Engineering in Indian Agriculture. An Introductory Hand Book*. Secunderabad: Centre for Sustainable Agriculture.

Levidow, L., Murphy, J., & Carr, S. (2007). Recasting "substantial equivalence": transatlantic governance of GM food. *Science, Technology and Human Values 32*(1), 26-64.

McEvoy, P. B., & Coombs, E. M. (1999). Biological control of plant invaders: regional patterns, field experiments, and structured population models. *Ecological Applications 9*(2), 384-401.
Mishra, S. (2006). Farmers' suicides in Maharashtra. *Economic and Political Weekly, 41*(16), 1538-1545.
Mishra, S. (2009). Made it. *Down to Earth, 17*(16), 28-29.
Mourik, R. M. (2004). *Did Water Kill the Cows? The Distribution and Democratisation of Risk, Responsibility and Liability in a Dutch Agricultural Controversy on Water Pollution and Cattles Sickness.* Maastricht University, Maastricht.
Nandy, A. (1987). From outside the imperium: Gandhi's cultural critique of the West *Traditions, Tyranny and Utopias. Essays in the Politics of Awareness*. New Delhi: Oxford University Press.
Nandy, A. (Ed.). (1990). *Science, Hegemony and Violence*. New Delhi: Oxford University Press.
O'Riordan, T., & Cameron, J. (Eds.). (1994). *Interpreting the Precautionary Principle*. London: Earthscan Publications.
Poppy, G. (2000). GM crops: environmental risks and non-target effects. *Trends in Plant Science, 5*(1), 4-6.
Prasad, S. (2001). *Exploring Gandhian Science: A Case Study of the Khadi Movement.* Indian Institute of Technology, Delhi.
Prasad, S. (forthcoming). Creative dissent: linking vulnerability, democracy and knowledge in India. In A. Hommels, J. Mesman & W. E. Bijker (Eds.), *The Vulnerability of Technological Cultures. New Directions in Research and Governance*. Cambridge: MIT Press.
Quartz, J. (2010). Creative dissent with technoscience in India: the case of non-pesticidal management (NPM) in Andhra Pradesh. *International Journal of Technology and Development Studies, 1*(1), 34-73.
Quartz, J. (2011). *Constructing Agrarian Alternatives. How a creative dissent project engages with the vulnerable livelihood conditions of marginal farmers in South India.*, Maastricht University, Maastricht.
Rajan, V. (1994). *The Case of the Red Hairy Caterpillar* Hyderabad: Think Soft Consultancy.
Rama Rao, C. A., Srinivas Rao, M., Srinivas, K., & Ramakrishna, Y. S. (2007). Adoption and impact of Integrated pest management in cotton, groundnut and pigeonpea. *Research Bulletin of the Central Research Institute for Dryland Agriculture, 2*, 32.
Ramanjaneyulu, G. V., Kuruganti, K., Hussain, Z., & Venumadhev, K. (2004). *Managing Pests without Pesticides*. Secunderabad: Centre for Sustainable Agriculture.
Rao, D. C. B. (2004). Village bids farewell to pesticides. (09.04.2004). *The Hindu*
Renn, O. (2005). *White Paper on Risk Governance: Towards an Integrative Approach*. Geneva: International Risk Governance Council.
Schumacher, E. F. (1973). *Small is Beautiful: Economics as if People Mattered*. London: Vintage Books.
Sharma, D. (2005a). No Bt cotton, no pests. Retrieved 13.04.2008, from Third World Network: http://www.twnside.org.sg/title2/sevice171.htm
Sharma, D. (2005b). No pesticides, no Bt cotton, no pests. Retrieved 12.12.2008, from India Together: http://www.indiatogether.org/2005/mar/dsh-punukula.htm
van Asselt, M., & Vos, E. (2006). The precautionary principle and the uncertainty paradox. *Journal of Risk Research, 9*(4), 313-336.
Visvanathan, S. (1998). A celebration of difference: science and democracy in India. *Science, 280*(5360), 42-43.
Visvanathan, S. (2001). Ancestors and epigones. *Seminar, 500*, 48-60.

Visvanathan, S. (forthcoming). Scripting sociology of science: between knowledge and democracy in India.
Waage, J. K., Hassell, M. P., & Godfray, H. C. J. (1985). The dynamics of pest-parasitoid-insecticide interactions. *Journal of Applied Ecology, 22*(3), 825-838.
Willoughby, K. W. (1990). *Technology Choice. A Critique of the Appropriate Technology Movement*. London: Intermediary Technology Publications.