Figure 1. Tunicate bloom. Close-up view of Salp colony.

Institution of Oceanography linked this tunicate bloom with cold water circular current[1]. But we found salps in the confined tropical coral reef environment. Moreover, it is believed that faecal pellets and bodies of salps carry biogenic carbon[3] to the sea floor, and salps are abundant enough to have an effect on the ocean's biological pump[7,8]. Hence, their occurrence and distribution in abundance are not only beneficial for coral colonies, but they also alter the ocean's carbon cycle, and thereby potentially play a role in climate change.

1. Gewin, V., In *Teeming Tunicate Bloom*, The Ecological Society of America, 2008, p. 60; http://www.famer.unsw.edu.au/media/Suthers_Frontiers2012.pdf (accessed on 13 February 2013).
2. Sutherland, K. R. and Madin, L. P., *J. Exp. Biol*., 2010, **213**, 2967–2975.
3. Madin, L. P., *Mar. Biol*., 1974, **25**, 143–147.
4. Anon, Salps; A string of salp captured in the Red Sea, 2013; http://www.itsnature.org/sea/other/salps/ (accessed on 13 February 2013).
5. Guzman, H. M., Cortes, J., Glynn, P. W. and Richmond, R. H., *Mar. Ecol. Prog. Ser*., 1990, **60**, 299–303.
6. Everett, J. D., Baird, M. E. and Suthers, I. M., *J. Geophys. Res*., 2011, doi: 10.1029/2011JC007310
7. Bruland, K. W. and Silver, M. W., *Mar. Biol*., 1981, **63**, 295–300.
8. Perissinotto, R. and Pakhomov, E. A., *Mar. Biol*., 1998, **131**, 25–32.

ACKNOWLEDGEMENT. We thank the Deanship of Scientific Research, King Abduaziz University for funding (Project No. 1433/150/428).

ABDULMOHSIN A. AL-SOFYANI
N. MARIMUTHU*
J. JERALD WILSON

Department of Marine Biology,
Facultyof Marine Sciences,
King Abdulaziz University,
P.B. No. 80207,
Jeddah 21589, Kingdom of Saudi Arabia
**e-mail: marinemari@hotmail.com*

Adaptive soil management

Adaptive soil management (ASM) is an important doctrine of sustainable agriculture and is the need of the hour for feeding a current population of seven billion people and more in the future. Although the concept of adaptive management was introduced in the late 1970s and has been applied to a wide range of resources and ecosystem management, there is a dearth of knowledge about the interdependencies and interlinking of this concept among academicians, policy-makers and regulatory agencies[1,2]. As a result, this strategy is still applied to various ecosystems without due consideration of the system principles. This letter summarizes a brief outlook on the ecological and economic benefits of ASM so that this concept can be interlinked with a wide range of resource management like adaptive environment management, adaptive nutrient management, adaptive water management, adaptive forest management, adaptive wetland management, etc.[1,2].

Agriculture is often considered as a 'culture' rather than a 'practice' and was predominantly wrought by the cultural practices and traditional wisdom of a particular society. Furthermore, the green revolution together with the subsequent progress in science and technology has contributed immensely to the introduction of mechanization and high-yielding hybrid varieties in agriculture and we have currently reached in an era of molecular breeding and genetically modified crops[3–6]. However, the rapid intensification of agriculture to meet the needs of a growing population[7], changing diets[8] and biofuel production comes at the cost of increased environmental pollution and soil degradation[7,9,10] and reduced carbon stocks in natural vegetation and soils[7]. So there is an intrinsic link between the challenges we face to feed the burgeoning world population and subsequent global environmental issues[4,5]. However, the successful operation of proper management strategies based on sustainability can provide practical solutions for tackling these issues[4,5].

Furthermore, conventional management strategies are based on the local or regional priorities or needs, and mostly targeted on short-term management gains rather than sustainable environmental management[11]. As a result, the uncertainties that will occur during implementation are not adequately addressed, or there is no provision for the allocation of additional resources for tackling an uncertain event or any kind of sudden changes that will happen during the policy implementation stage. Hence, the idea of adaptive management was introduced to tackle the uncertainties in environmental management[11–14].

One of the important arenas of adaptive management is ASM. Soil is a vital part of the biosphere and a primary sink of pollutants. However, it is estimated that approximately 30% of land is degraded or contaminated by various anthropogenic activities[14]. The heavy contamination of soil with noxious hazardous chemicals reduces the quality of soil drastically. Once they enter into the soil, many of the pollutants can redistribute and circulate into other environmental compartments through volatilization, leaching, transport of soil, etc.[14]. On the other hand, unscientific agricultural practices reduce the quality of the soil and threaten the life of soil organisms. Hence, there is a growing need for methods to evaluate soil quality degradation and its changes and sustainable management practices to overcome these issues. Over the last few decades, many efforts have been made to stop the degradation of soil and enhance soil productivity, but the process of adoption of adaptive management in agriculture is slow. Earlier, the soil management practices were projected only for limited benefits. Furthermore, the availability of

technical and managerial information related to this aspect is limited. In this context, adaptive management principles come in the forefront and provide practical solutions for the sustainable management of the soil system.

However, the successful integration of ASM principles will require the simultaneous application of water, soil, sediment, wetland and watershed conservation measures. It also depends upon the farming and agronomic practices, erosion control, integrated pest management, groundwater recharge programmes and soil carbon initiatives. As a result, ASM will help design site-specific remediation strategies for the decontamination of various agroecosystems. ASM will also help design regional strategies for soil carbon sequestration, an important remedial measure in the context of enhancing terrestrial carbon sinks with a view to mitigating atmospheric carbon dioxide levels as emphasized in the Kyoto Protocol on climate change.

1. Dessie, Y., Schubert, U., Wurzinger, M. and Hauser, M., *Environ. Sci. Policy*, 2013, **27**, 21–31.
2. Westgate, M. J., Likens, G. E. and Lindenmayer, D. B., *Biol. Conserv.*, 2013, **158**, 128–139.
3. Evenson, R. E. and Gollin, D., *Science*, 2003, **300**, 758–762.
4. Beddington, J., *Philos. Trans. R. Soc., London, Ser. B*, 2010, **365**, 61–71.
5. Tester, M. and Langridge, P., *Science*, 2010, **327**, 818–822.
6. Godfray, H. C. J. *et al.*, *Science*, 2010, **327**, 812–818.
7. Fox, J. E., Gulledge, J., Engelhaupt, E., Burow, M. E. and McLachlan, J. A., *Proc. Natl. Acad. Sci. USA*, 2007, **104**, 10282–10287.
8. Marlow, H. J., Hayes, W. K., Soret, S., Carter, R. L., Schwab, E. R. and Sabaté, J., *Am. J. Clin. Nutr.*, 2009, **89**, 1699S–1703S.
9. Meehan, T. D., Werling, B. P., Landis, D. A. and Grattona, C., *Proc. Natl. Acad. Sci.*, 2011, **108**, 11500–11505.
10. Heimann, M. and Reichstein, M., *Nature*, 2008, **451**, 289–292.
11. Walters, C. J., *Adaptive Management of Renewable Resources*, MacMillan Pub. Co, New York, 1986.
12. Holling, C. S., *Adaptive Environmental Assessment and Management*, Wiley, London, 1978.
13. Lee, K. N., *Compass and Gyroscope: Integrating Science and Politics in the Environment*, Island Press, Washington, DC, 1993.
14. Abhilash, P. C., Powell, J. R., Singh, H. B. and Singh, B. K., *Trends Biotechnol.*, 2012, **30**, 416–420.

P. C. ABHILASH[1,*]
RAMA KANT DUBEY[1]
VISHAL TRIPATHI[1]
PANKAJ SRIVASTAVA[2]
J. P. VERMA[1]
H. B. SINGH[3]

[1]*Institute of Environment and Sustainable Development, Institute of Agricultural Science, Banaras Hindu University, Varanasi 221 005, India*
[2]*Eco-Auditing Group, National Botanical Research Institute, Rana Pratap Marg, Lucknow 226 001, India*
[3]*Department of Mycology and Plant Pathology, Institute of Agricultural Science, Banaras Hindu University, Varanasi 221 005, India*
e-mail: pcabhilash@hotmail.com

Smile with Science

By – Santosh K. Sharma
e-mail: santosh_ujj@yahoo.com