review, I have not, misrepresented the thrust of Masani's arguments.

3. What is the difference, if any, between scientific knowledge and commonsense knowledge? Masani says: 'This has an easy answer ... scientific knowledge is a refinement of commonsense knowledge.' Surely, this is not an answer. For what does one mean by 'refinement'? When does one say that a set of explanations is a 'refinement' of another set of explanations?

4. I had remarked that Masani does not systematically analyse the relationships between science, engineering, and the 'useful arts' (i.e., crafts). Masani claims that what is relevant is the relationship between science and craft, and not between science and technology. According to him: 'The craftsman is invaluable to science in providing good apparatus to the experimenter.... Without the craftsman the scientist is lost.' Are particle accelerators and radio telescopes the contributions of craftsmen to science? The role of instruments in scientific methodology is a critical and important issue. Masani has nothing to say about this in his monograph.

5. About the 'trivialization' of technical terms. In claiming that moral evil is human teleological noise, clearly, the technical term 'noise' is being used, at best, metaphorically. Metaphorical extensions of technical terminology are powerful aids to creativity and conceptual thinking. But it is useful to distinguish between 'productive' metaphorical usages and 'unproductive' ones. Masani and I seem to differ in our perceptions of whether referring to 'moral evil' as 'human teleological noise' is a productive metaphorical usage or not.

6. Finally, Masani objects to my references to his 40-year-long association with Wiener's personality and his works, and the pervasive influence of this in the style and substance of his monograph. He claims these are irrelevant to scientific methodology. But I was not reviewing scientific methodology *per se*, but Masani's account of it in a certain historical context. My observations should be interpreted in the larger context of Masani's writings on Wiener – especially, his extended biography of Wiener. I would like to assure him, however, that when I wrote that 'Wiener inevitably tends to loom large in his thinking horizon'. I did not intend this in any pejorative sense whatever. After all, many of us have our own *gurus*.

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Methane emission from rice paddies: Need for a downward revision of global estimate

CARBON dioxide, CH_4, CFC-11, CFC-12 and N_2O are the most important greenhouse gases that are affected by human activities[1]. Among these, CH_4 is the only gas which directly affects the tropospheric chemistry, and forms a part of the highly interactive chemical system that largely determines the background concentration of the hydroxyl radical, which is the most important oxidizing gas in the troposphere[1]. Rice paddies are considered to be among the most important sources of atmospheric CH_4, contributing from 60–100 Tg per year[2–5]. Estimates, however, are beset with many assumptions[6]. Our analysis of published results indicates that CH_4 contribution from rice paddies has been *substantially overestimated*.

The frequency distribution of CH_4 emission rates ($N = 350$) compiled from a variety of studies in different regions[7–35] was markedly skewed towards left (Figure 1, curve a). In this and the following analyses, all data points are given equal weightage irrespective of the time of measurement, treatment or region. Thus, no attempt was made to integrate the CH_4 flux for the whole season, and all values were converted to mg $CH_4\,m^{-2}h^{-1}$. About 67% values were $< 16\,mg\,m^{-2}h^{-1}$; of these, 54% values were $\leq 8\,mg\,m^{-2}h^{-1}$. Values greater than 40 mg $CH_4\,m^{-2}\,h^{-1}$ were mostly from pot experiments[9–12] and a few from field experiments[14,30,33], involving high inputs of chemical fertilizers/paddy straw/horse manure. In these pot experiments inputs included 12–24 g rice straw per 3 kg of soil[9–12]. The field experiments had inputs of 30 t ha^{-1} of *Sesbania rostrata* or 2 t ha^{-1} of rice straw[14]; 710 kg ha^{-1} NH_4HCO_3 + 30 t ha^{-1} horse manure[30]; 694 kg ha^{-1} K_2SO_4/KCl + 1042 kg ha^{-1} rapeseed cake or only 1042 kg ha^{-1} rapeseed cake[33]. Curve b in Figure 1, illustrates the frequency distribution ($N = 326$) after these values were excluded. Curve c in Figure 1, represents the distribution of emission rates ($N = 280$) when all data from pot experiments[9–12, 34], including lower values (in addition to those from high inputs in refs. 14, 30, 33), were excluded.

Simple averages from data in Figure 1 (curves a–c) ranged from 12.29 to 14.89 mg $CH_4\,m^{-2}\,h^{-1}$ and were associated with high standard deviation values (Table 1). These averages compare with 12.92 (ref. 3), 14.58 (ref. 36), 9.99–33.33 (ref. 7) and 21 mg $m^{-2}\,h^{-1}$ (ref. 5) reported earlier.

Based on the FAO statistics, Neue and Roger[37] estimated a harvested rice area of 73.26 m ha for irrigated rice, 38.95 for rain-fed rice and 11.45 for deep-water rice (total $1.236 \times 10^{12}\,m^2$). Aselmann and Crutzen[3] have used the value $1.31 \times 10^{12}\,m^2$ for rice land area. Globally, 60% of the harvested area is managed under a triple cropping system, 15% is double cropped and 25% is cropped once a year[5]. CH_4 emission period ranges from 85 to 126 days

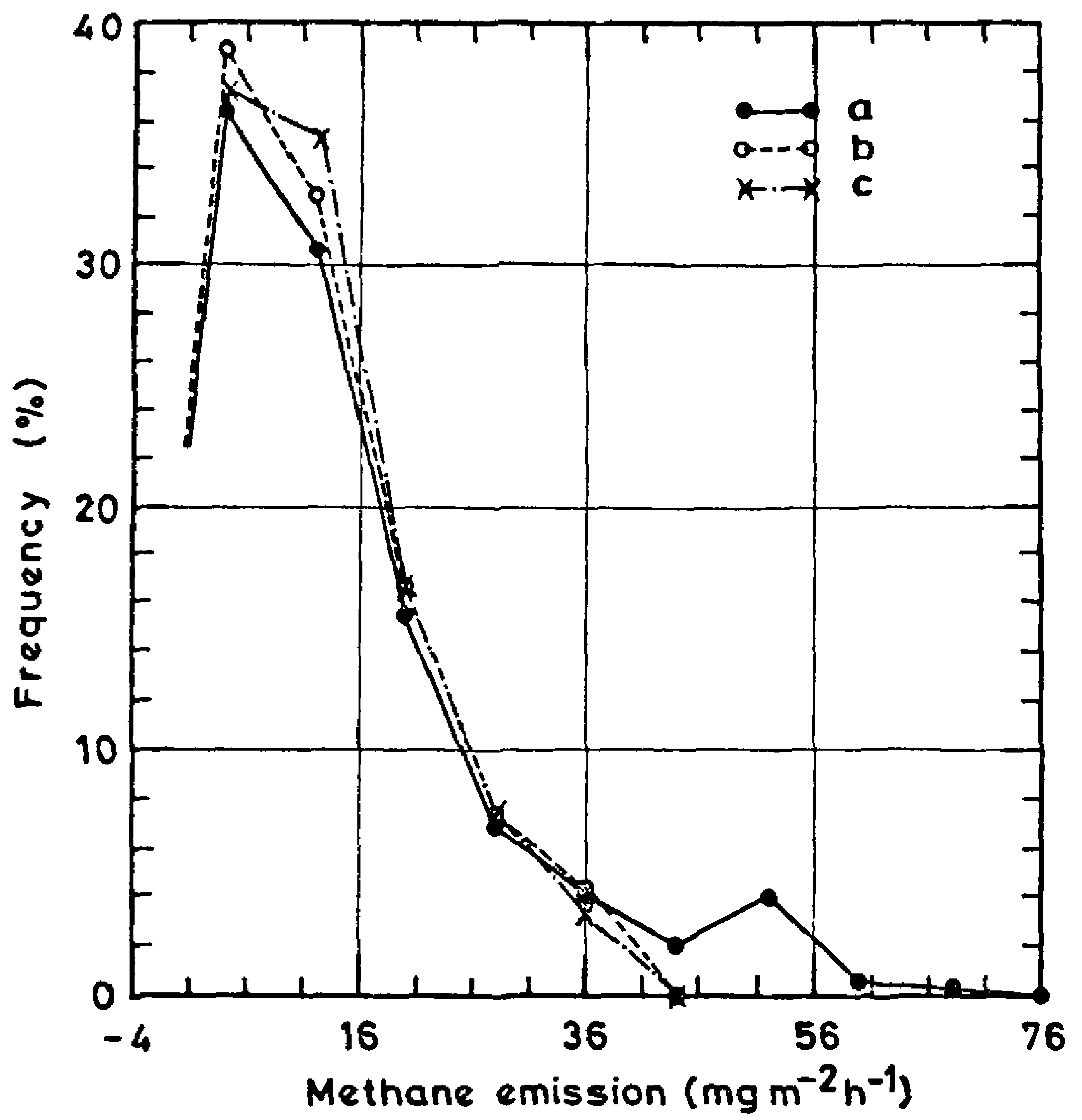

Figure 1. Frequency polygon for CH_4 emission rates. Each data point is an average of several but variable number of replicates. *a*, all data, *b*, exceptionally high values due to high inputs of chemical fertilizer/organic matter excluded; *c*, values from all pot experiments excluded in addition to exceptionally high values from field experiments due to high inputs of fertilizer/organic matter.

Table 1. Calculated CH_4 emission from rice paddies on the basis of data in Figure 1

	Emission rate (mg CH_4 m^{-2} h^{-1})	Annual emission (Tg CH_4 yr^{-1})
All data		
Simple average	14.89 (±12.95)	49.13
Geometric mean	9.32	30.76
Exceptionally high values removed[1]		
Simple average	12.29 (± 8.88)	40.58
Geometric mean	8.24	27.19
Values for all pot experiments removed[2]		
Simple average	12.34 (± 8.14)	40.72
Geometric mean	8.97	29.60

Values in parentheses are standard deviations.

[1] Values from experiments with heavy doses of chemical fertilizers and paddy straw/horse manure were excluded. Most of these were pot experiments.

[2] Values from all pot experiments involving chemical fertilization and organic matter amendment were excluded.

around the world[6] and averages 105 days. Using 1.31 × 10^{12} m^2 rice cultivation area, a CH_4 emission period of 105 days and average emission rates, the total global emission varies from 40.58 to 49.13 Tg yr^{-1} (Table 1). Because of the pronounced skewness in the data and high standard deviations associated with simple averages, it would seem preferable to use geometric means. Based on geometric means, the total CH_4 emission varies from 27.19 to 30.76 Tg yr^{-1} (Table 1).

Inclusion of the data from artificial pot experiments or from field experiments with very high inputs of organic matter in calculations of global emission may not be realistic. A recent review indicated that the CH_4 flux response to the application of fertilizer or/and organic matter ranged from negligible to dramatic (–75 to +6857% compared to control), and varied from year to year, among periods within a growing season, and from treatment to treatment[38]. Additionally, if harvested wetland rice area of 1.236 × 10^{12} m^2 is used as calculated by Neue and Roger[37], the global estimate reduces to 25.68–27.84 Tg CH_4 yr^{-1}. We suggest that these values could be considered a reasonable estimate until all rice-growing regions and rice ecologies are adequately covered by flux measurements. These estimates depend much on the CH_4 emission period, which may vary substantially in different geographic regions. Assuming a 30 d emission period, as argued by Sinha[39], the estimate for global emission reduces to 7.34–7.95 Tg yr^{-1}. This estimate compares with 7.08 Tg yr^{-1} assessed by Sinha[39] on the basis of rice yield and 30 d CH_4 emission period. Thus, there is a need for substantial reduction in the global estimate of CH_4 emission from rice paddies.

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Nomenclature of super heavy elements

Scientists of different countries have made different claims on synthesis of new elements. As their methods of identification were different, the criterion for discovery of elements[1] remained under dispute for a long time. Hence, the literature has reports on the same element with different names and symbols, which leads to confusion. Recent changes by IUPAC[2] in the names of elements 101–109 have evoked mixed reactions, especially in USA. This is because some old names have been reassigned different atomic numbers, in an effort to solve the dispute.

Some actinide elements were named after the place of discovery in accordance with their rare earth counterparts. For example, eka-Europium was named Americium, and eka-Terbium was named Berkelium. It is interesting to note that eka-Hafnium (104) has aptly been christened after Dubna, just as Hafnium was named after Copenhagen (Hafinia in Latin). The elements with atomic numbers 105 and above have been named after eminent scientists. (105 – Joliotium (Jl); 106 – Rutherfordium (rf); 107 – Bohrium (Bh); 108 – Hafnium (Hn); 109 – Meitnerium (Mt)). The earlier name Seaborgium suggested by the Berkley group for element 106 has not been accepted by IUPAC because it does not favour naming the elements after scientists who are alive. Some subtle changes have occurred with respect to symbols: Mv, Lw and Ha have now become Md, Lr and Hn, respectively[3–5].

Elements yet to be ratified are given temporary appellation derived from the following unique Greek/Latin roots[6]: 0 = nil; 1 = un; 2 = bi; 3 = tri; 4 = quad; 5 = pent; 6 = hex; 7 = sept; 8 = oct; 9 = enn. Instead of this system, a simpler representation with Z is also followed. For example, $(110)O_2$ is the dioxide of the element ununnilium (Unn).

Worldwide acceptance of the recent IUPAC recommendations[7] would end the confusion that prevails in the naming of these 'superheavy' elements.

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