

# WILD VEGETABLES AND MICRONUTRIENT NUTRITION

*Studies on the significance of wild vegetables  
in women's diets in Vietnam*

BY

BRITTA M. OGLE



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### ABSTRACT

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The principal aim has been to investigate the contemporary role and importance of edible wild plants in the diets of women in different agro-ecological regions of Vietnam. Field studies were undertaken in four villages in the Mekong Delta (MD) and the Central Highlands (CH) in 1995-1999. Data collection included rapid appraisal techniques, botanical identification, dietary assessments (7-day food frequency recall), anthropometry, blood sampling (haemoglobin, serum ferritin, serum retinol and C- reactive protein) and analysis of vegetable samples (dry matter, selected minerals and vitamins, tannins and phytic acid). A food variety analysis was used to test the adequacy of diets

Over 90 wild plant species were documented, many with multiple functions as foods, medicines and livestock feeds. In the dietary assessment 29 species were reported. Most women used a combination of home produced, commercial and wild vegetables. A high 72 and 43% respectively of the vegetables consumed in the MD and CH sites were gathered (rainy season). They contributed significantly to micronutrient intakes, especially vitamin A, calcium, vitamin C and folate. They added considerably to food diversity and women with the most diverse diets had relatively adequate nutrient intakes. The species used and importance of wild plants varied considerably with region, season and ethnicity.

The main conclusions are that edible wild plants continue to make important contributions to the nutrient intakes of women. If this is neglected in diet assessments our understanding of the overall dietary adequacy may be misinterpreted and much valuable knowledge of traditional food diversification may be lost. A food variety analysis can be a useful tool in identifying groups with inadequate diets. The dual role of many species as dietary components and in preventive health care deserves greater attention.

*Key words:* edible wild plants, gathered vegetables, Vietnam, micronutrients, rapid appraisal, dietary assessment, nutrition status, chemical analysis, food diversity, folate, medicinal foods.

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*" When we eat vegetables, we think of medical functions also "*

(Comment by woman in Mekong Delta village)



## LIST OF ORIGINAL PAPERS

The thesis is based on the following papers, which will be referred to in the text by their Roman numerals:

- I. Ogle BM, Hô Thi Tuyêt, Hoàng Nghia Duyêt and Nguyễn Nhut Xuân Dung.  
Food, feed and medicine? The multiple functions of edible wild plants in Vietnam (submitted for publication).
  
- II. Ogle BM, Nguyễn Nhut Xuân Dung, Trần Thanh Đô and Leif Hambraeus.  
The contribution of wild vegetables to micronutrient intake among women: an example from the Mekong Delta, Vietnam. *Ecol Food Nutr* 2001,40:159-184
  
- III. Ogle BM, Hà Thi Anh Đào, Generose Mulokozi and Leif Hambraeus.  
Micronutrient composition and nutritional importance of gathered vegetables in Vietnam. *Int J Food Sci Nutr* (Accepted Feb 2001)
  
- IV. Ogle BM, Phạm Hoàng Hưng and Hô Thi Tuyêt.  
The significance of wild vegetables in micronutrient intakes of women in Vietnam. An analysis of food variety. *APJCN* 2001,10: 21-30
  
- V. Britta M Ogle, Madelene Johansson, Hô Thi Tuyêt and Lena Johanneson  
Evaluating the significance of dietary folate from wild vegetables in Vietnam  
*APJCN* (accepted Feb 2001)

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## ABBREVIATIONS

ACC/SCN	Administrative Committee on Coordination/Sub-Committee on Nutrition
BMI	Body Mass Index
BMR	Basic Metabolic Rate
CH	Central Highlands
CRP	C-reactive protein
DDS	Dietary Diversity Score
EI	Energy intake
FAO/FTP	Food and Agriculture Organisation/ Forest Trees and People
FFQ	Food Frequency Questionnaire
FVS	Food Variety Score
HPLC	High Performance Liquid Chromatography
IP	Inositol phosphate
IVACG	International Vitamin A Consultancy Group
MAFI	Ministry of Agriculture and Fisheries
MD	Mekong Delta
NIN	National Institute of Nutrition
NOV	Naturally occurring vegetables
PAL	Physical activity level
RBP	Retinol Binding Protein
RRA	Rapid Rural Appraisal
UNICEF	United Nations Children's Fund
UNU	United Nations University
VAC	Integrated garden system in Vietnam (Garden, pond, pigs/poultry)
VADD	Vitamin A Deficiency Disorders
WHO	World Health Organisation

## INTRODUCTION

The role of wild plants in human nutrition has attracted the interest of researchers from many fields throughout history. Numerous publications in both social and natural sciences have provided evidence on the past and present nutritional role of edible wild plants (FAO/FTP 1991, Grivetti et al. 1987, Grivetti and Ogle 2000, Scoones et al. 1992). However, the significance of the continued use of such “hidden food resources” remains a low priority in many policy areas where they belong, including those of sustainable agriculture, biodiversity and public health (Blench 1997, Haddad and Oshaug 1999, IIED 1995). Fleuret’s conclusion in 1979 that even “nutritional studies do not seriously consider the role of these foods in local diets” remains relevant today (Fleuret 1979).

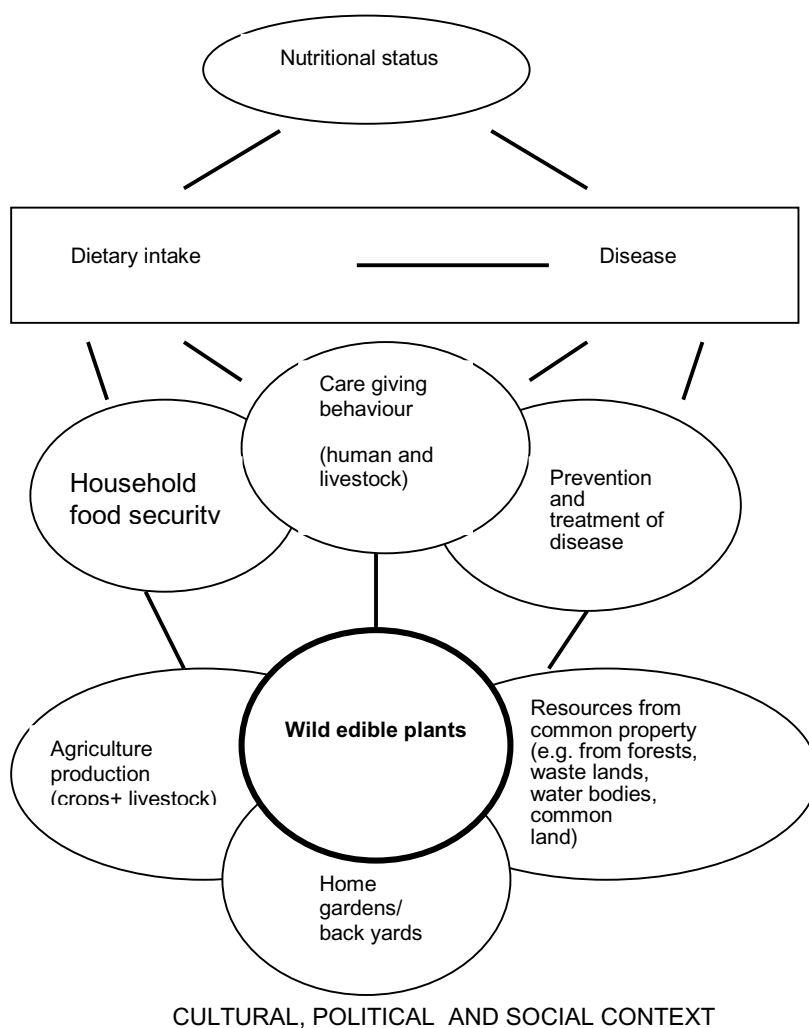
Scoones et al. (1992) used the term “hidden harvest “ in their review and annotated bibliography on wild foods and agricultural systems. They raised a number of key issues of relevance to agriculture and food policy, including the following:

- 1) wild foods are important in the whole range of agricultural systems, in all parts of the world
- 2) wild foods have significant economic value and this needs to be taken into account in agriculture and forestry planning
- 3) wild genetic resources are vital for the future of agricultural production, and so conservation and management of such resources by farmers will help ensure the maintenance of biodiversity
- 4) wild foods are often collected from common property areas, thus securing access to such areas is important for sustaining the livelihoods of the poor
- 5) wild foods are particularly important during certain seasons of the year and during major stress periods, such as in droughts
- 6) wild foods make especially significant contributions to the diets of women, children and the poor.

It is clear from the literature that it is difficult to generalise regarding the use and value of wild edible plants. An enormous variety of species is used, but their uses vary greatly with region, ecological conditions and socio-cultural factors (FAO/FTP 1991, Grivetti et al. 1987, Grivetti and Ogle 2000).

## What are edible wild plants?

I have chosen to use the term 'wild' plants in this thesis. There are many linguistic pitfalls for this diverse group of local plants that are part of the food basket in many parts of the world. They may grow wild in some areas but be protected and managed by some farmers in other regions or sometimes include agricultural escapees or botanical crossovers. Researchers have tried to address the question of what species to include by using such terms as gathered, hidden, local, minor, natural, non-cultivated, traditional, unconventional and under-utilised (Chewya and Eyzaguirre 1999, Falconer 1990, FAO 1988). None of these terms, however, can capture any more accurately this diverse group of neglected food plants or differentiate them more clearly from domesticated, cultivated species.



*Figure 1. Nutrition and the multifunctional roles of wild foods resources (adapted from UNICEF 1990, Antonsson-Ogle et al.2000, Eide and Oshaug 1999)*

### **Multi-functions of edible wild plants**

The position of edible wild plants in local food resource systems and their multiple and often over-lapping functions in relation to nutrition can be set in a framework as outlined in Figure 1. The upper part of the framework builds on the widely used conceptual framework of nutrition problems in society (Jonsson 1984), with subsequent adaptations to also include “care giving behaviour” and not only human food and health concerns but also those of livestock (Engle et al. 1997, Eide and Oshaug 1999). Factors of food, care and health at the household level are closely interlinked and strongly related to women's knowledge, control of resources and position in society.

The lower part of the framework places edible wild plants in the broader setting of resources available for food acquisition (Antonsson-Ogle et al. 2000). They are harvested from very diverse habitats in rural food systems, niches that Chambers (1990) has called “unobserved microenvironments”. This includes not only home-gardens, backyards and fields, but also many additional sites not usually considered as food resource habitats, for example dykes, common lands, forests, road sides, water bodies or marsh lands. The knowledge, values and beliefs of the caregivers, most importantly women, will determine the nutritional contribution of wild plants through their multiple use as foods, feeds or medicines.

### **Micronutrient data on edible wild plants**

Micronutrient data are part of the results in many different types of studies on edible wild plants, including anthropological and ethnographic work, botanical inventories, chemical analyses, dietary intake reports and intervention studies (Becker 1983, 1986, Booth et al. 1992, FAO 1989, 1991, Grivetti and Ogle 2000, Kuhnlein and Turner 1991, Scoones et al. 1992). This illustrates the interest in this research area by many disciplines and brings to our attention the wide range of inputs, from the agro-ecological and botanical, to the socio-cultural aspects, that is needed to capture the nutritional importance of wild plant use. It also shows that many studies have been conducted in professional isolation e.g. they are simple inventories or composition reports and that more systematic and interdisciplinary studies of the current nutritional role of wild plants are relatively few. From our recent review on research on wild foods and micronutrients, we conclude that

there is a lot of evidence that edible wild plants provide important micronutrients throughout the year in many rural agricultural societies. Such species thus play critical roles during periods of drought and civil unrest, and knowledge of these species may be the most important determinant as to whether individuals or families maintain nutritional wellbeing, become malnourished, or succumb (Grivetti and Ogle 2000).

### **Dietary intake studies**

A subset of the research publications on wild edible plants has included dietary intake studies (Table 1). These provide important examples of the major nutritional contributions that wild plants can make to different population groups and at the same time they illustrate many of the problematic features of dietary assessments in wild edible plant research. These include for example the necessity to identify botanically an often large number of species that may be used, the variation between sites in species use, the social and ethnical differentiation in use, their often low status and the lack of data on chemical composition. From a methodological viewpoint the studies in Table 1 illustrate how researchers have made use of combinations of methods to make in depth assessments possible (Fleuret 1993, Ogle and Grivetti 1985, Omori and Greksa 1996, Uiso and Jones 1996).

The food intake of individuals can be measured through a number of established dietary assessment methods, commonly grouped into qualitative (e.g. food frequency questionnaires or dietary history) and quantitative (e.g. 24h recalls, food records, duplicate meals or food frequency recalls, quantified through the use of standard portions). These methods are well described in the literature, including the differences in the type of information they provide, the demands on equipment, time and skills of the researcher and respondent and their strengths and weaknesses (Beaton et al. 1997, Gibson 1990, Thompson and Bayers 1994, Willett 1998). Basically the choice of method should be guided by the objectives of a study, the level of the desired information (pattern of use, quantities used of food or food category, group average of nutrient intake or actual individual intake) and the resources available. An overview of the key features of retrospective and prospective methods commonly used in field studies and some methodological aspects of each are provided in Table 2.

**Table 1. Edible wild plants and micronutrients: Dietary intake studies 1980's-1990's**

Author	Title	Type of study/sample size/ target group	Methodology	Key findings	Comments
Campbell BM (1987)	The use of wild fruits in Zimbabwe	3 ecological areas, 225 households (hh) Adults, children pre-school and school-age	Questionnaire, 24-h recall with added questions on wild foods.	Most hh use wild fruits. Often the only type of fruits in diet. 24 h recall does not catch consumption of wild foods; additional questions needed. Reasons given for consumption: good vit C source important for primary school children and for the rural poor people, protect fruit trees of preferred species, active marketing of wild fruits. Consumption has not decreased with deforestation	
Dethwyler KA (1986)	Infant feeding in Mali, West Africa: Variations in belief and practice	136 children	Repeated open ended interviews with mothers, 24 h recall	Focus on patterns of introduction of solids to infant diets. Casual mentioning of wild fruits to very young children and use of "less common vegetables" Mangoes and other wild fruits sometimes given to very young children	
Fleuret A (1993)	Dietary and therapeutic uses of fruit in three Taita communities	25 children 3-17 y, random sub sample of larger study	Child following, recorded intake 1 week, 3 seasons	97 species used regularly or seasonally, 77 wild. Over 50 % of school children ate only wild fruits during school days. Such snack foods eaten 3-7 times daily. Wild fruits added to children's diets from 3-4 months. Fruits in therapy mostly given to children.	The nutritional role of wild fruits is neglected as they are not seen as part of meals or as foods. Contradicts their central role in supplying some vitamins and minerals Roots and leaves from wild fruit trees used as home remedies
Gibson et al. (1991)	Food consumption patterns and trace element intakes of children from the Wosera, Papua New Guinea	67 children 6-10 years	24 h recall interactive analysis of vegetables: Ca, Cu, Mg, Zn	Some analysis of the role of 4 green leafy vegetables (cultivated and wild analysed together) Green leaves major source of Ca(67%), Fe (42%), Zn (21%), Mg (58%) Overall intake of Ca/Fe/Zn inadequate=2/3s of RDA in 43%, 25%, 76% of children; low bioavailability due to high fibre intakes	
Herzog et al. (1994)	Consumption and composition of gathered wild fruits in the V-Baoule, Cote D'Ivoire	545 interviews with 40 adults and children	Monthly 24-h recalls for 1 year chemical analysis of 11 species of fruits	At least 50 % of all fruits eaten are wild. In addition many escapees, also people are familiar of another 22 species Macro and micronutrient data for the fruits include proximate analysis, Ca, Fe, Mg, K, Vit C, carotenoids, thiamin, riboflavin, niacin	

Hongo et al (1989)	Element intake of the Gidra in lowland Papua: Inter-village variation and the comparison with contemporary levels in developed countries	4 villages 6-8 households	Weighed food records before cooking for 14 days Estimates of intake of 17 elements	Focus on element intake of all foods eaten and water. Wild seeds noted as important for the high Fe intake. Wild cycads/lotus seeds contributed 32 % of total Fe intake. Comparison of elemental intakes with data from Japan, USA and Europe	
Humphry et al (1993)	Food diversity and drought survival. The Hausa example	Integrated approach 2 villages with different geographical and botanical situations 112 households (29 men and 83 women)	One season, questionnaire survey, repeated interviews (2-3 times per hh). Identification of species, frequency of use, and consumption by hh, collection of samples, analysis of 21 species proximate analysis and 34 species re selected minerals	Comparing food procurement during drought and normal years. 84 wild dietary species identified, 93% hh collected wild foods regularly for own consumption, 39 eaten by over 50% of hh, 19 % hh also sold wild plants for extra income. Chemical analysis of 34 popular plants including Ca, Fe, Cu, Zn, Mg, Mn	
Huss-Ashmore and Curry (1991, 1994)	Dietary intake among rural women in Swaziland	110 women in rural areas, + 24 h recall on pre-school children	24 h recall repeated monthly for one year; nutrient profile by analysis using combined data base from previous studies + USDA and South African food tables	Only 26 % of leafy vegetables used are cultivated. On average 15-90 g of wild veg are eaten daily. Diet adequate in iron, vit A vit C	Part of larger study on nutrition and crop production. Reconfirms that overall food pattern remains very similar to that of 50 years ago
Kunaratnapruk et al. (1998)	Yearly household record of food from the forest for home consumption by rural villagers in north east Thailand	7 households in 1 village 2 hh landless, 5 average economy	Weighed food records for 1 year	Species used, data provided by household including average weight of different types of forest foods, seasonal variations, food budget savings.	Combined with RRA see Somnasang et al. (1985)
McGregor, J (1995)	Gathered produce in Zimbabwe's communal areas changing resource availability and use	3 villages, 44 households	24 h recall, focus on fruits and leafy vegetables	80 % of fruits eaten by poor hh are wild. Highly seasonal. Late dry season especially 39 species of leafy vegetables important contribution to micro nutrients	Differential use by socio-economic group. Increased use of weeds on disturbed lands
Nordeide et al. (1996)	Nutrient composition and nutritional importance of green leaves and wild food resources in an agricultural district, Koutiala, in Southern Mali	2 cross-sectional surveys Random selection of household clusters 179 urban and 111 rural households	Food frequency + focus group discussions; analysis of 7 leafy vegetables (proximate, amino acids, minerals, carotenoids)	Wild foods important in both rural and urban hh but more so in rural. Data on %hh using different species in two seasons Rich in micro- nutrients Chemical analysis of 7 major species	Notes that Mali (like many poor countries) lacks national food composition tables
O'Dea et al. (1988)	An investigation of nutrition related risk factors in an isolated Aboriginal community in Northern Australia: advantages of a traditionally-oriented life-style	Australian Outstation Aboriginal group, 18 adults, 6 children	Food record 9 + 7 days, biochem. analysis, of several blood parameters including Hb, red-cell folate	Data on wild food consumption (animal and plants); only one case of anaemia, high folate intake	Study focus on type 2 diabetes with change in lifestyle.

Ogle BM and Grivetti LE (1985)	Legacy of the Chameleon: Dietary utilisation of wild plant resources in four ecological zones in rural Swaziland	Cross sectional study with rural households in 4 ecological zones +school children in same areas	Inventory of species; 1 year- frequency recall + 24 h recall among 211 adults; 3 day food recording of 140 school children; analysis of 29 species (proximate and trace elements)	224 species of fruits and vegetables used. All hh consume wild plants; 39% hh use wild vegetables more than cultivated species; 56 % use wild vegetables throughout year	
Omori K and Greksa LP (1996)	Dietary patterns and dietary adequacy of Highland Pwo and Sgaw Karen of NW Thailand	Pre school children and their mothers 8 villages, 148 adults and 95 pre-school children	24 h recall and food frequency records within anthropological study 3 seasons sampled	All gathered vegetables and fruits in addition to home produce. Significant difference between villages in food diversity More diverse diet where more wild foods were used. Lower Kcal/vit A/Fe/Vit C in group with less diverse diets. Children's diets inadequate in all micronutrients except vit C	Illustrates difference in use of wild foods between villages in same area. Illustrates higher nutrient density in more diverse diets
Osuhor PC (1990)	Weaning practices amongst the Hausas, Nigeria	238 women interviewed on infant/child feeding		Focus on weaning and weaning foods. Mentions use of wild foods in relish which is served most days with staple foods. Some bitter leaves are also used to rub on nipple to stop child from breast feeding	
Rahman et al (1993)	Can infants and young children eat enough leafy vegetables from a single meal to meet their daily vitamin A requirement?	118 children, age 6-35 months	Interviews with mothers on food intake of child and perceptions on feeding leafy vegetables to infants and children	Feeding study using traditional leafy vegetables, which could be both cultivated and wild. 58%/73%/100% of children in age groups 6-11m/12-17m/18-35 m took over 75% of RDA in single meal. 87% ate spontaneously. Only two mothers did not want to feed traditional leafy vegetables to young children. Children ate 25-143 g in one meal	
Shrimpton R (1989)	Vitamin A deficiency in Brazil: Perspectives for food production oriented interventions	Analysis of national household expenditure survey data and regional food consumption figure with regards to vitamin A content	Calculates Vitamin A scores and groups foods accordingly Regional analysis of sources of vitamin A in diets	Notes that many native Brazilian fruits have high contents of carotenoids and high vitamin A scores. They are ignored in modern development, often destroyed with new developments and there is a trend that people also in areas where high carotenoid fruits are available, replace these by apples, pears and oranges which have higher status Calls for promotion of indigenous species	
Sommasang et al. (1985)	Natural foods Thailand	8 villages in 3 provinces in North Thailand, 13 households	Rapid Rural Appraisal	Up to 50% of all foods consumed by some villagers are natural. Includes vegetables growing naturally in rice fields and forests but also insects and small aquatic animals in rice fields. Gives chemical composition of 7 major vegetables. Notes that some wild vegetables thrive with use of pesticides and fertilisers others disappear. Notes that there are some restrictions in which plants pregnant women should use	Combined with weighed food records see Kunrattananpruk et al. (1998)

Uiso F and Jones T (1996)	Consumption patterns and nutritional contribution of <i>Crotalaria brevidens</i> (mitto) in Tarime district, Tanzania	74 women in one district, recruited through women's groups	7-day frequency recall 24h recall, quantified analysis of $\beta$ -carotene in 2 samples	49% of vegetables consumed were wild; vegetables constitute 23% of all foods by frequency; 21 species of wild fruits; 16% of meals have wild veg; important source of vit A as few animal products in diet	
Villard L and Bates CJ (1987)	Dietary intake of vitamin A precursors by rural Gambian pregnant and lactating women	62 pregnant and 119 lactating women in one location and 36 pregnant women in another location	Monitored for 1 year including assessment of vitamin A foods twice weekly, by weighing and recall, analysis of carotene and retinol content of representative food samples.	Major seasonal variations in vitamin A intake, mostly as carotenoids. Ripe mangoes and palmoil were important seasonal sources of carotenoids, as were leaf sauces. Few animal products used. Average intake of vitamin A below RDA and large individual variations in intake. No physiological signs of deficiency	
Zeitlin et al. (1992)	Mothers' and children's intakes of vitamin A in rural Bangladesh	2 sites involving several villages each, 370 women and their young children (98% of all hh with children age 3-20 months)	7 month dietary study, monthly 24-h recalls	Dark green leaves were major source of vitamin A- the only one available in abundance. During two months mangoes were major supplier of carotenoids. Focus on traditional foods rather than wild. On average intake of vitamin A among women was 72% of RDA for lactating women. With breast milk included, intake of children came close to RDA. Concludes that traditional diets need protection and promotion.	
Zinyama et al. (1990)	The use of wild foods during periods of food shortage in rural Zimbabwe	7 villages small farm hh in low rainfall area	Questionnaire survey 194 hh (275 interviews)	Large variation between villages. In villages where wild plants are commonly used, 78/47/41 % of hh use these during drought as principle strategy to cope. Overall in all villages 14 % use wild foods as principle strategy of coping in drought. Wild vegetables and fruits also used in normal times. In drought, government assistance is a more important strategy but 57% of those with Govt assistance also used wild plants and 87% of those who gather also got Govt assistance during drought	

**Table 2. Considerations in the use of established dietary assessments methods in cross cultural field surveys**

Method Issues	Retrospective		Prospective	
	24-hour dietary recall	Food frequency recall	Estimated food records	Weighted food records
Main features	Interview or self administered recall of all food items eaten during the last 24 hours	Self administered or interview using a pre-structured list of foods and specified period (year-month-week); common for large epidemiological studies	Respondent records all foods eaten over given period (often 3-7days)	Respondent weighs +records all foods eaten over given period (often 3-7days)
Information provided	Usual intake and food pattern if repeated in representative sample	Measures usual intakes, mostly in terms of frequencies but standard servings may also be used to quantify	Can provide an accurate estimate of actual intake if respondent is thorough and conscientious	Can provide an accurate account of actual intake if respondent is thorough and conscientious
Procedure/ assessment tools needed	Structured interview with probing questions to assist memory; photos, models or household measures to quantify; food composition tables to calculate nutrient intake	Pre-determined list of foods, mostly designed for frequency information only but sometimes quantified by use of household measures, pictures or models;	Written record of all food items and drinks; use of household measures to quantify; use of food composition tables to calculate nutrient intake	Scales and recording forms distributed; Thorough instruction needed; food composition tables used to calculate nutrient intake
What strengths?	Can be used for both quantitative and qualitative data; easy, quick, low demand on respondent; open ended; easy to use across different populations	Relatively easy to administer- can be self administered or used in interviews; relatively low burden on interviewer and respondent; relatively low cost (time, equipment, training, analyses)	Less problem of omission than in methods relying on memory; open ended, low demand on researcher in the data collection phase;	Same as for estimated record but more demand on respondent; higher risk for change of actual intake to simplify
What weaknesses?	Respondent may not answer accurately or forget specific food items; single day will leave out unusual foods, seasonal foods and variation over days; requires careful description of foods eaten in each interview	Limited number of foods listed; Respondent may not remember accurately, especially over long period; if the lists are long, respondents tend to overestimate frequencies; cannot get details of types of mixed foods or pattern requires special considerations when used in multi cultural settings	Not possible in illiterate populations; respondent must be highly motivated to keep accurate records; may affect food intake	Requires special design in illiterate populations; High demand on respondent and researcher; may affect food intake; respondent must be highly motivated to keep accurate records; resource demanding and often used only for small sample sizes
Validation	Comparison to weighed food record or observation; use of BMR and activity records	Use of BMR and activity records	Combine with spot checks using 24h recall; use of BMR and activity records	Food portions can be collected for analysis; use of BMR and activity records
Other issues	High demands on interviewers		More difficult for researcher to code individual entries	More difficult for researcher to code individual entries

One of the most commonly used dietary assessment methods in wild plant studies is the 24h dietary recall. It has many advantages in assessments of the usual intakes of groups, as the interviews are easy and open ended and can be used also with illiterate respondents, the demand on the respondent is low and the coverage can be wider and more representative. It is relatively easy to train co-workers and avoid interviewer bias. It has the weaknesses that it needs to be repeated over different days and seasons to give a more representative picture of usual intake and those foods eaten more seldom are easily omitted or forgotten.

Other researchers have used food frequency questionnaires. These are usually designed to reflect long term diet, often 1 year, and are popular in large, self-reporting, epidemiological studies. In the wild edible plant studies where they have been applied they have been used in face-to face interviews, primarily to allow qualitative descriptions of species used and ranking of their importance. Among the often cited weaknesses of this method is the problem in accurate quantification and the risk of over-reporting when recall covers a long period (Gibson 1990, Thompson and Bayers 1994, Willett 1998).

A few researchers have made use of the weighed food records method (Hongo 1989, Kunarattanapruk et al. 1998 and O'Dea et al. 1988). Although it is a relatively accurate method it is also time consuming and demanding on both the respondent and the researcher. As it requires weighing in connection with each meal, it also disturbs physically and socially the eating process and may thus cause a change in food intake.

In this review over the last few decades I have found no published dietary intake studies that has made use of the diet history method. It uses a combination of 24h recall and questions regarding the usual food intake, and a food frequency questionnaire to assess long term intake. It would lend itself well to assessments of current use of edible wild plants within the overall diet and changes in the use over a longer period. It is however time demanding on both the respondents and the researcher.

There are many well-known sources of error in dietary investigations, in the collection of data, in the conversion from food information to nutrients and in the interpretations that are made (Beaton et al. 1997, Lennernaes 1998). The problems of under-reporting or over-reporting are general in dietary assessments and it is therefore necessary to include in the study design some measurement of relative validation (Gibson

1990, Goldberg and Black 1998). These may be the use of a biochemical marker, such as urinary nitrogen excretion, validation through comparative use of two different dietary assessment methods or a comparison of the reported energy intake and the estimated energy requirement (Goldberg and Black 1998, Hambraeus 1998).

Dietary assessments in cross-cultural and multi-ethnic settings require special considerations (Cassidy 1994, Teufel 1997). The demands on the investigator are heavier, as face-to-face interviews and translations may be necessary, respondents may not be used to quantifying the amounts eaten by individuals, standard recipes are not available and databases for calculations may be incomplete. In such situations Cassidy (1994) suggests combinations of the best features of qualitative and quantitative techniques, development of survey instruments in situ and creativity and openness to possibilities.

### **Lack of composition data on wild foods**

The conversion of consumption data on wild foods to nutrient intake often poses practical problems. Composition data, especially micronutrient data on wild foods, are not usually included in food composition tables, or the values are questionable, as the tables do not indicate references or analytical methods used (Grivetti and Ogle 2000). In this situation, researchers interested in the role of wild foods in contemporary diets either need to make assumptions founded on unreliable tables or use substitute values from similar products, or they have to include analyses of chemical composition. Table 3 provides an overview of published research from the 1980s and 1990s that have integrated chemical analysis into the studies to allow interpretation of the nutritional significance of wild foods in diets.

**Table 3. Edible wild plants and micronutrients: Integrated studies including chemical analysis of micronutrients 1980's-1990's**

Author	Title	Type of study/sample size/target group	Methodology	Key findings	Comments
Booth et al. (1992)	Nutrient content of selected indigenous leafy vegetables consumed by the Kekchi people of Alta Verapaz, Guatemala	Integrated study	Chemical analysis of 13 leafy vegetables	Part of dietary study but only chemical analysis presented in this paper. Mineral analysis and carotenoids (AOAC and HPLC)	Uses FAO promotion of vegetables and homegardening to justify importance of study
Gibson et al. (1991)	Food consumption patterns and trace element intakes of children from the Wosera, Papua New Guinea	Integrated study Table 1a	Analysis of vegetables: Ca, Cu, Mg Zn	Some analysis of the role of 4 green leafy vegetables (cultivated and wild analysed together)	
Herzog F et al (1994)	Consumption and composition of gathered wild fruits in the V-Baoule, Cote D'Ivoire	Integrated study see Table 1a Chemical analysis of 11 species of fruits	Proximate analysis, vitamin A, thiamin, riboflavin, niacin vitamin C, Fe, Mg; K, Ca	Wild fruits make important contributions to nutrition, for variation and complementation. They are in danger of disappearing and this may be harmful to nutrition status	
Humphry et al (1993)	Food diversity and drought survival. The Hausa example	Integrated study see Table 1a Analysis of 34 species	Proximate analysis 21 species selected minerals of 34 species	Chemical analysis of 34 popular plants including Ca, Fe, Cu, Zn, Mg, Mn	
Malaisse and Parent (1985)	Edible wild vegetable products in the Zambesian woodland areas. A nutritional ecological approach	Integrated study 20 key informants	2 year inventory based on weekly surveys , interviews with key informants and chemical analysis of selected nutrients	Identification of 241 species. Samples and analysis of 184. Chemical analysis of 15 oil seeds/seeds, 11 roots, 11 flowers, 25 tubers/bulbs, 31 leafy vegetables, 91 fruits- including proximate analysis, Fe, Ca, P	
Nordeide et al. (1996)	Nutrient composition and nutritional importance of green leaves and wild food resources in an agricultural district , Koutiala, in Southern Mali	Integrated study see Table 1a	Analysis of seven leafy veg (proximate, amino acids, minerals, carotenoids)	Rich in micro- nutrients	Notes that Mali (like many poor countries) lacks national food composition tables
Ogle BM and Grivetti LE (1985)	Legacy of the Chameleon: Dietary utilisation of wild plant resources in four ecological zones in rural Swaziland	Integrated study Table 1 a Analysis of 29 species of vegetables	Proximate, calcium and 11 trace elements using x-ray fluorescence techniques	Summary table and comparison with previously published data wild and some common cultivated vegetables and fruits	
Smith et al. (1996)	Mineral values of selected plant foods common to southern Burkina Faso and to Niamey, Niger, West Africa	Sites in 3 villages in 2 provinces with different botanical situations	Study period bridging dry and rainy season. Focus group interviews with villagers, identification of species used, sample collection for analysis. Samples collected around fields and purchased from local markets	36 wild foods and three local cultivated vegetables analysed re Cu, Fe, Mg, Mn, Zn. 36% of plants used in local diets were wild. In terms of volume, wild plants accounted for 20 % of all food items eaten Several wild vegetables had higher mineral values than available cultivated vegetables	

### **Micronutrient deficiencies and the role of edible wild plants**

Micronutrient deficiencies are among the high priority public health concerns in many countries. Several global meetings, including the UNICEF World Summit for Children (1990), the ACC/SCN Policy Conference on Micronutrient Malnutrition (1991) and the International Conference on Nutrition (1992) have called for global action to address micronutrient deficiencies. In response to this many universal vitamin A supplementation programmes for young children have been initiated and been successful in reducing vitamin A deficiency disorders (VADD) in the short term. Considerable less attention is given to the broader problems of meeting dietary requirements of other micronutrients in different population groups.

The long-term strategy to alleviate VADD and other micronutrient problems must be food based and include the protection and promotion of diverse food cultures and diets. Vegetables and fruits in general are an important category in food based approaches as sources of multiple micronutrients. Within this group, gathered wild vegetables and fruits deserve greater attention, as our reviews show numerous examples on how they are easily accessible, culturally accepted and inexpensive sources of vitamins and minerals to many rural population groups. However, the data on the contribution of local vegetables and fruits, even the cultivated varieties, is often too fragmentary to be useful in the development of food based strategies (Haddad and Oshaug 1999, Ruel and Levin 2000). Yet the diversity and number of examples from different regions indicate their importance at an aggregated level.

### **Dietary intake data and the use of wild foods in Vietnam**

The National Institute of Nutrition (NIN) in Vietnam has conducted a number of surveys on food intake in different ecological areas of Vietnam (NIN, Nutrition General Survey 1987-90, Tu Giay et al. 1991). Generally they show a relatively diversified diet, typically based on rice and vegetables with small quantities of meat, fish, eggs and fruits added, but also considerable differences in the food habits and food supply between regions and agroecological zones (Tu Giay et al. 1991, NIN, National General Survey 1987-90). The daily per capita vegetable consumption in the national survey of 1987-90 was below 200 g, but there was a regional variation from a low of 106 g/capita/day in the South Coastal

region, to a high of 265 g/capita/day in the North Mountain region. Data on the consumption of wild vegetables, “*Rau Dai*”, are lacking.

Vietnam has a wealth of wild plants, which traditionally have been included in the food basket (Bui Minh Duc 1988). Over 600 plant species are reported to have been utilised as vegetables (*Rau Dai*) in the past, of which 120 common available species have been compiled in a publication that includes botanical data and some chemical and nutritional information (Nguyen Tien Ban and Bui Minh Duc 1994). Some data on the chemical composition of 60 species were also included in the 1972 edition of the Vietnamese food composition tables (Tu Giay et al. 1972). In the revised edition published more recently, 12 wild species were re-analysed (National Institute of Nutrition/Ministry of Health 1995).

Data on the current consumption of wild plant foods is very limited. Information from the national vitamin A survey in 1991 indicated that children in the 6-59 months age group had a vegetable consumption of 2.35 kg/week and that 36% of these vegetables were wild (NIN/MAFI/FAO 1991). Some recent small field surveys also indicate that wild plants are integrated in rural home gardens and that rural households continue to include wild vegetables in their diets (Gessler and Hodel 1997, Nguyen Thi Yen et al. 1994).

VADD and anaemia are both public health concerns in Vietnam (FAO 1990, Ha Huy Khoi et al. 2001, National Institute of Nutrition 1986, 1991). The Government of Vietnam introduced a universal distribution of vitamin A capsules to children between 6 and 60 months in 1993. They have since successfully lowered the prevalence of clinical xerophthalmia to <0.05% prevalence among <5 year old children (Bloem and Gorstein 1995, Ha Hui Khoi et al. 2001). The current concerns are focussed on the long term solutions, as studies show that the concentration of retinol in breast milk is very low and the consumption of vitamin A rich foods among children is low (Ha Hui Khoi et al. 2001).

Anaemia is also a major public health concern in Vietnam, with a reported prevalence of over 50 % among non-pregnant women (Nguyen Xuan Ninh et al. 2001). A large proportion of this is assumed to be due to low iron status, but other factors including helminth infections are common. A recent national survey indicated that 40-50

percent of pregnant women in major cities were anaemic and over 20 percent of maternal deaths were attributed to anaemia (NIN/UNICEF/CDC/PAMM 1995).

The National Institute of Nutrition also recognises that there are many other potential problems of micronutrient deficiencies in Vietnam, especially among pregnant women, infants, adolescent girls and the elderly, but have not yet assessed the magnitude (Ha Huy Khoi et al. 2001).

### **AIMS OF THE STUDY**

The principal aim of this study was to investigate the contemporary role and importance of wild plants in the diets of women in different agro-ecological regions of Vietnam.

The specific objectives were:

to investigate the current role and trends in the use of wild plant species as vegetables in selected sites and identify factors that promote, restrict or endanger their consumption.

to evaluate the potential contribution of wild vegetables to selected micronutrient intakes of rural women in specific sites.

to analyse selected antinutritional factors of significance for bioavailability.

to evaluate the association between food diversity, especially the role of wild vegetables, and nutrient intake and health status among women

## STUDY POPULATIONS, MATERIALS AND METHODS

The studies included in this thesis are based on a series of field surveys conducted in the period 1995-99, and laboratory analysis of popular wild plants and selected blood parameters. Four villages in two agro-ecological regions of Vietnam were selected for the field studies, as indicated in Figure 2 (map).



Figure 2 Map of Vietnam and location of study sites

## Study areas

The four study sites were selected to illustrate the diversity of natural vegetables in different farming systems and agro-ecological settings. Two were in the Mekong Delta (MD), which is one of the most fertile regions in Vietnam, and is characterised by the very intensive agriculture, which is based primarily on rice production, either irrigated or rain-fed. Another two villages were selected in the Central Highlands (CH), a region that by contrast is sparsely populated and where over half of the area is under forest cover. Typical for this region is the settled agriculture in the narrow valleys surrounded by rugged, densely forested hills and mountains.

All study sites were considered problematic from an agricultural production viewpoint. The Mekong Delta villages had problems of acid soils or saline influx and the Highlands villages had very limited land for irrigated rice production and limited marketing potential due to poor infrastructure (Working group on Acid Sulphate Soils, 1992). In the Mekong Delta the study sites were located in Can Tho and Soc Trang provinces. In the Central Highlands two forest villages in two districts in the Thua Thien – Hue province were selected, one close to the border of Laos and the other neighbouring the Bac Ma nature reserve.

Several criteria guided the selection of field sites (Paper I-II). Within each agro-ecological region, staff at the local university suggested areas known for high plant diversity. Two districts with a higher proportion of poor smallholders and villages with lower agricultural production were then selected. The selected sites were villages where university staff had already established contacts for on-farm research or were involved in development programmes in collaboration with non-governmental organisations. In all four study sites most of the households relied on agriculture for their livelihoods and most of the households had lived in the area for 10 years or longer. Typical for all sites was also the diversity in the farming systems, with various combinations of crop production and livestock rearing, often including also aquaculture and fruit production (Table 1, Paper I).

### **Study population**

Key characteristics of the women included in the study are described in Paper II and Paper IV. The sites in the two regions differed with respect to ethnicity of the population, with the Mekong Delta population being exclusively ethnic Vietnamese (*Kinh*) while the Central Highlands population included *Kinh* as well as two minority groups, the *CaTu* and the *PaKo* (Paper II, IV).

### **Study design**

A schematic outline of the study design is provided in Figure 3. It includes a timeline of the field surveys in the two regions and an overview of the number of women included in each survey. Each survey was conducted together with staff from local universities, in the Mekong Delta together with Can Tho University and in the Central Highlands with the University of Agriculture and Forestry in Hue. Permission for the surveys was secured through the university departments and the local authorities by the university staff involved and briefings with local authorities were held after each survey. A local member of the Women's Union and a staff member from the local clinic accompanied the research team to the communities each time. Ethical permission was also obtained from the research ethics committee, Uppsala University. All subjects gave oral consent to the formal interviews and health check up.

### **The initial survey: a Rapid Rural Appraisal (Paper I)**

In each of the sites an interdisciplinary team consisting of the principal researcher and 4-5 staff and students from the local university carried out an initial survey. In two of the villages the research team lived in the villages during the surveys, thus maximising the opportunities for informal learning and observations. In the villages where this was not possible the team stayed in a nearby school for the duration of the fieldwork. Rapid Rural Appraisal (RRA) techniques, including participatory mapping, village/forest walks, transects and vegetable competitions were used (de Koning and Martin 1996, Feldstein and Jiggins 1994, Pretty et al. 1995). Plant specimens were collected for botanical

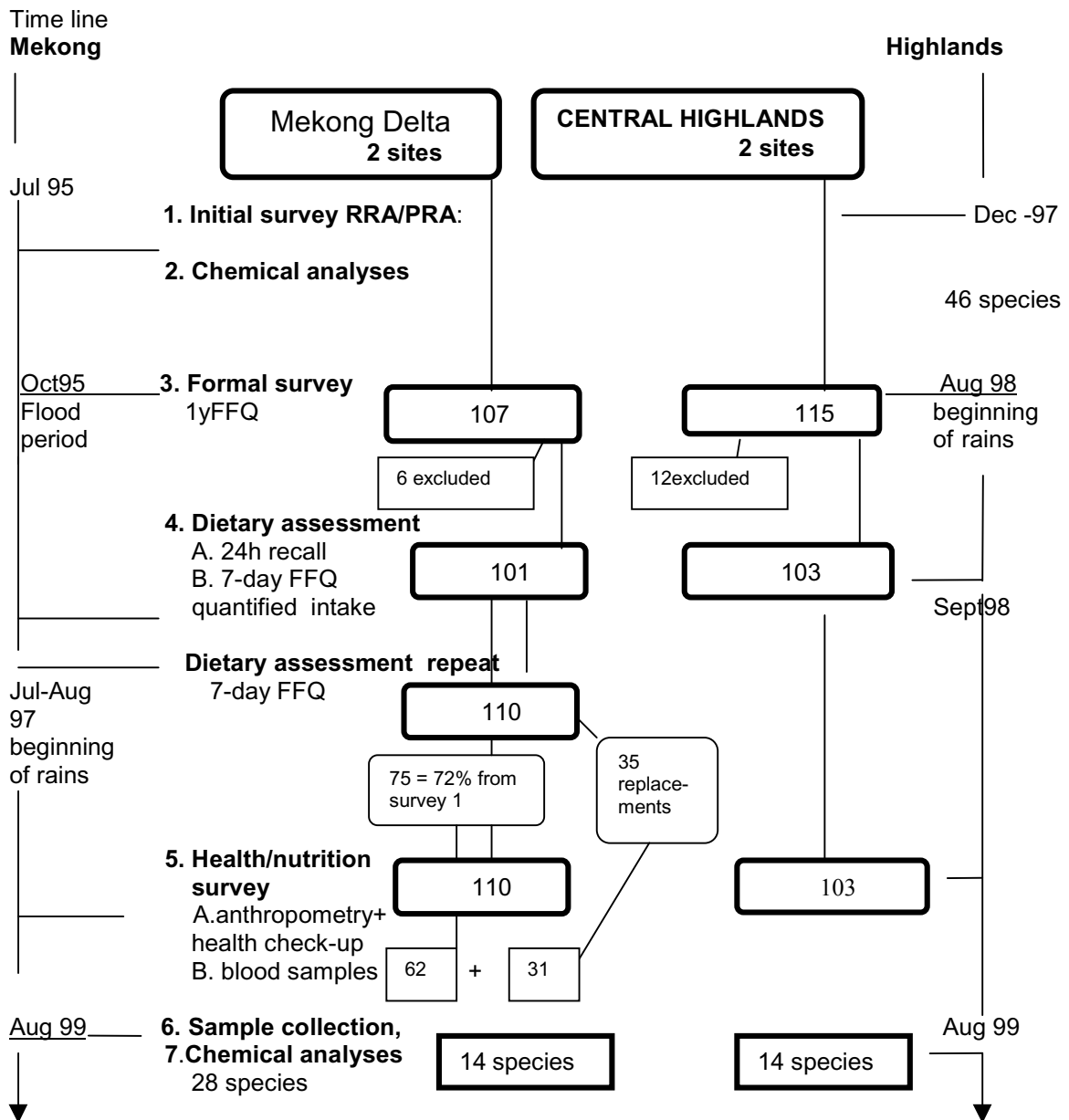


Figure 3. Overview of research design

identification (Pham Hoang Ho 1970-72, Le Van Truyen and Nguyen Gia Chan 1999, Vo Van Chi 1997).

The collected plant specimens were also used in key informant interviews and group discussions with adults on habitat, changes in abundance, season of availability and local classifications and uses (Figure 4). The groups also discussed changes over time in availability of natural vegetables, protection or management, the role of natural vegetables compared to home grown or commercial varieties and their visions of constraints and potentials for future use.



Figure 4. Key informant and group interviews in the Mekong Delta

### **Formal survey on the use of vegetables (Paper I)**

The first formal survey focused on the frequency of use of wild plants in comparison to home grown and commercial vegetable species in the previous year (Paper I). A 1 year food frequency methodology (1yFFQ) was used (Willett 1998). For each region a basic list of cultivated and natural vegetables was developed for the frequency recall on the basis of information from the RRA. The resulting list for the Mekong Delta consisted of 66 species and for the Central Highlands, 55 species. Face to face interviews with 107 and 115 women, respectively, in the Mekong Delta and the Central Highlands, were carried out in the homes of the respondents.

### **Dietary assessment surveys (Paper II, IV)**

To make possible an evaluation of the significance of wild vegetables in the overall diet of the respondents, an adapted food frequency methodology with a recall period of seven consecutive days (7dFFQ) was used in food consumption interviews with the same women respondents (Eck et al.1991, Krall et al.1987). The survey instruments were developed on the basis of information from the initial visits to the study areas and included commonly used foods divided into twelve food categories, as described in Paper II and IV. Specific care was taken to cover foods commonly available in the area, especially local vegetables, fruits and indigenous fish species. Face to face interviews were used also for this survey.

In the Mekong Delta a repeat survey was made in connection with the health and anthropometry survey, thus making possible a seasonal comparison of dietary intake in the beginning of the rainy season and during the flood period (Paper II).

### **Food variety analysis (Paper IV)**

In addition to the standard analysis of energy and nutrient adequacy of the diet that was done on the basis of the 7dFFQ, a food variety analysis was carried out (Hatloy et al. 1998, Hodgson et al. 1994, Hsu-Hage and Wahlqvist 1996). Using the data sets from the dietary intake and health/anthropometry surveys in the rainy season in the 4 sites, the association between the variety of foods consumed and the adequacy of the nutrient intake was tested. Special emphasis was given to the significance of wild vegetables also

in this analysis, including an analysis of the differences between regions and between ethnic groups.

### **Health and nutrition status investigations (Paper II, IV)**

Anthropometric surveys and health status check-ups of the study populations were included in the field surveys of 1997 (Mekong Delta) and 1998 (Central Highlands). With the assistance of qualified doctors from the universities of Can Tho and Hue, individual health examinations were included to provide information on general health status and current or recent illnesses. To assess anthropometric status the heights and weights of all subjects were recorded using Tanita Digital Solar Scales and the Raven Minimetre measuring tapes. Body mass index (BMI) and basal metabolic rate (BMR) were calculated. For validation of the reported dietary energy intake (EI), BMR factors were calculated as energy intake EI/BMR (FAO/WHO/UNU1985, Goldberg and Black 1998).

In the Mekong Delta study venous blood samples were analysed for haemoglobin (Hb), serum ferritin, serum retinol, retinol binding protein (RBP) and C-reactive protein (CRP). These were selected as useful indicators of the nutritional status of the women and to test the association with the self reported dietary intake data (Paper II, IV). The haemoglobin levels were assessed in the field with HemoCue units. C-reactive protein levels were also assessed in the village using NycoMed CRPcards. Blood samples were transported in ice boxes each evening to Can Tho hospital where the serum ferritin levels was determined. Frozen samples were transported to the Benh Vien Cho Ray Hospital in Saigon where retinol-binding protein was determined using enzyme-linked immunosorbent assays, and to the National Institute of Nutrition, Hanoi, for analysis of serum retinol using HPLC.

### **Chemical analyses of vegetables (Paper III and V)**

Chemical analyses of selected nutrients in the wild vegetable species in the sites were included at several points in the study. An initial analysis of dry matter, selected minerals and vitamins of 48 species was done in 1995 at the Departments of Animal Science and Soil Science, Can Tho University. After the dietary assessment, samples of the 28 most commonly used species were collected in the study sites using the procedure

proposed by Greenfield and Southgate (1992) and these were analysed as described in Paper III and V. The analyses were made at the National Institute of Nutrition, Hanoi (dry matter, total ash, Ca, Fe, Zn), at the Chalmers University, Gothenburg (carotenoids, phytic acid) and at the Swedish University of Agricultural Sciences (tannins, folate).

## SUMMARY OF RESULTS

### **The initial survey, Rapid Rural Appraisal (RRA)**

The initial RRA indicated that over 90 species of wild plants were used as vegetables (Paper I, Table 3). These were collected from very diverse habitats in the vicinity of the houses or fields and included both aquatic and terrestrial plants. In the Mekong Delta villages several of the most abundant and popular species were water plants that were also sold in local markets. In the Central Highlands many of the well known species were forest plants, but women noted that many of these were far away and for convenience the most popular species were sometimes transplanted closer to home.

The dominant part of the wild species used as vegetables had more than one function in the livelihood systems of people (Paper I). About a third of the species were recognised for their therapeutic or curative properties, forty percent were used also as livestock feeds, and one fifth were used for all three purposes. *Centella asiatica*, *Commelina communis*, *Passiflora foetida*, *Sauropus androgynus*, *Enydra fluctuans* and *Portulaca oleracea* were among the species also used as home remedies. Among the vegetable species also used as livestock feeds *Amaranthus spp.*, *Alternanthera repens*, *Commelina communis*, *Ipomoea aquatica* and *Passiflora foetida* were popular.

### **Formal survey 1: use of vegetables**

The 1-year food frequency survey (1yFFQ) on vegetable consumption was designed on the basis of information from the initial survey (Paper I). It indicated that over 90 percent of the study population made use of some wild vegetables. The most commonly used species are listed in Table 2, Paper I.

In all sites women used a combination of wild, cultivated and commercial vegetables. There was however a significant difference between the regions in women's views of the relative importance of the different categories of vegetables. Seventeen

percent of the women in the Mekong Delta indicated that they relied most frequently on wild vegetables and an additional 62 percent mostly combined the use of wild vegetables with home produced and commercial varieties (Figure 1, Paper I). In contrast only a quarter of the women in the Central Highlands study areas relied mostly on wild vegetables, alone or in combination.

Through the use of wild plants women added 1-18 species of vegetables to their diets. Popular species were used daily or almost daily by a majority of women but several of the major species were very site specific. Examples of such species include *Eleocharis dulcis*, *Ipomoea aquatica*, *Limnocharis flava*, *Nasturdium officinale* and *Nymphaea lotus*. These were used daily by many households in at least one of the study villages, but some, for example *Eleocharis dulcis* and *Limnocharis flava* were unknown in other locations. In the Central Highlands the analysis by ethnic group indicated that over a third of the plants used by one ethnic group were not known or not used by other groups although they lived in the same eco-system.

### **Formal survey II: quantified dietary assessment**

The 7-day Food Frequency survey (7dFFQ) provided estimates of the energy and nutrient intakes of women in the four study villages (Paper II, IV). The mean energy intakes of 9.3 and 8.5 MJ/day (Mekong Delta and Central Highlands, respectively) were within the dietary recommendations of Vietnam, but were still somewhat low considering that most women were involved in farm labour. The mean intake was relatively adequate with respect to energy, protein, calcium and vitamin C, but low with respect to fat, riboflavin and iron. There was a large seasonal difference in the mean intakes of several micronutrients, with considerably lower intakes in the flood period, especially of vitamin A. The distribution of nutrient intakes was also uneven and in the flood period more than a third of the women reported intakes of <50 percent of RDA of vitamin A, vitamin C, iron and riboflavin.

With respect to vegetable consumption, 62 species were recorded, of which almost half were gathered in the wild. The quantitative contribution of different types of wild vegetables is illustrated in Table 4, Paper II. Women added up to 16 species to their diet through the use of wild vegetables, and 76% and 43 %, respectively, of the total

vegetable intake in the Mekong Delta and the Central Highland group came from wild species.

Wild species made significant contributions to the overall intake of vitamin A, calcium and iron, as illustrated in Paper II (Figure 3) and further in Paper III (Figure 2) and Paper IV (Figure 2). With respect to folate intake, 21 and 14 percent, respectively, in the Mekong Delta and the Central Highlands came from wild vegetables (Paper V, Figure 1).

### **Food variety analysis**

The food variety analysis illustrated that women consuming a more varied diet (the highest tertile= a mean of 21-39 foods) had nutritionally relatively adequate diets, with the exception of iron and riboflavin intakes (Paper IV, Table 4). The variety of foods from most food groups was higher in the high food variety tertile, including a higher variety of wild vegetables.

Importantly, the food variety analysis also illustrated significant variations between the ethnic groups in the nutritional adequacy of the diets (Paper IV, Table 5). One of the minority groups in the Central Highlands, the *PaKo*, had a diet that was more varied and more nutritionally adequate than the other groups and they were also the group consuming the greatest variety of wild vegetables. Overall we concluded that a food variety analysis could be a useful tool in capturing the dietary significance of wild vegetables.

### **Formal survey III: Health and nutrition status investigation**

The anthropometric characteristics of the study population are presented in Paper II and IV. Women in the study were typically small, with mean heights of 1.52 and 1.48 m and mean weights of 48 and 43 kg, respectively, in the Mekong Delta and the Central Highlands. The mean body mass index was 20.3 and 17.6, respectively, in the two regions. Approximately 15% and 19 %, respectively, in the Delta and Highlands had a BMI lower than 18.5, which is the WHO cut off point for chronic undernutrition.

The analysis of selected blood parameters in the Mekong Delta population showed that 36 % of the women were anaemic, i.e. had haemoglobin levels <120g/L, of

which 11% were <110 (Paper II and IV). The mean serum ferritin value was 137 ng/mL with 15 percent <30 ng/mL. Only 5 % had iron deficiency anaemia, i.e. both low haemoglobin and serum ferritin <12ng/mL. The mean serum retinol value was 42 µg/dl and no women had values <20µg/dl, which is the cut off value for vitamin A deficiency according to IVACG. The mean RBP was 20.8 mg/L and 18 percent had values below the normal range (<17mg/L, IVACG). Ocular evaluation of CRP levels indicated that nine percent of the women had acute infections.

### **Chemical analysis of vegetables**

The results from the chemical analysis of 28 commonly used species are presented in Papers III and V. All but one of the analysed species had higher carotene concentrations than the locally most common cultivated species, i.e. sweet potato leaves and mustard greens and half of the species also had higher calcium content and 12 species had higher iron content than the cultivated alternatives mentioned. Species with relatively high calcium content included several major species such as *Basella rubra*, *Centella asiatica* and *Commelina communis*, all of which contained >200mg Ca/100g. Species with high iron content included *Alternanthera sessilis*, *Commelina communis* and *Houttuynia cordata*.

The content of β-carotene was relatively high in the 11 species analysed, ranging from over 5000 µg/100g in three of the species (*Basella rubra*, *Limnocharis flava* and *Sauropus androgynus*) to around 2500 µg/100 g in *Commelina communis*. At the consumption levels reported in the study wild vegetables contributed considerably to the overall vitamin A intake even when retinol equivalents were calculated as 1/26 of β-carotene. This is the recently proposed conversion factor for green leafy vegetables, instead of 1/6 of β-carotene and 52% of α-carotene, as is given as standard in food composition tables (de Pee et al. 1995).

With respect to the tannin levels, six species were in the range of 8-54 mg/g fresh material, while other species had non-detectable levels. Considering the mean quantities consumed, one species, *Ipomoea aquatica*, had concentrations that were likely to interfere with mineral uptake. There was also a wide range in the concentrations of inositol phosphates (IP), but only four species had > 100 mmol/100g (Table 5, Paper III).

## **DISCUSSION**

We have carried out these field studies in Vietnam, an ecologically and culturally very diverse country, at a time of rapid economic development (1995-1999). The development in the agricultural sector has been particularly remarkable in the 1990s, with several-fold increases in rice production, making Vietnam the world's second largest exporter of rice. For the small-scale farmers the economic development has also provided many other opportunities to diversify their production and improve their household economy. In relation to nutrition this is a typical “transition” setting where major dietary changes often take place (James et al. 2000, Popkins 1998). It is of particular interest to focus on the use of a very traditional group of foods in such a setting and evaluate their use and potential in improving nutrition in the long term. The people in Vietnam are very proud of their food traditions and the richness and regional diversity in the food culture. Special efforts are made to encourage farmers to continue with well integrated and highly diversified small scale food systems to meet both economic and nutritional needs (Tu Giay & Duong Hong Dat 1991, Tu Giay & Tu Ngu 2001, VACVINA 1994). Health considerations are an integral part of food selection and traditional plant foods are used in many therapies (Le Van Truyen & Nguyen Gia Chan 1999). Protection and promotion of culturally well known foods as part of nutrition improvement strategies is therefore of interest, as this is known to require less educational input than the introduction of new foods (Booth et al. 1993).

A central question in the evaluation of the current significance of wild edible plants in this setting is the usefulness of the methods we have selected for the studies and the external validity of our research.

### **Study sites and design**

Four villages in two regions have been the basis for the research. The villages were selected to illustrate wild plant use in different agro-ecological settings and among different ethnic groups. However, considering the selection procedure, the geographical diversity in Vietnam and the cultural influences of diet from the over 50 ethnic minorities, the external validity is limited. The studies should be seen as pilot examples

indicating the need to place more attention on the potential significance of edible wild plants in nutrition in Vietnam.

### **Methodological complementarity**

*“Mixed qualitative-quantitative research designs promote cultural sensitivity”*

(Cassidy 1994)

Several researchers have noted the need for multiple methodologies and involvement of multidisciplinary teams in research on the nutritional significance of wild plants (Gibson et al. 1991, Grivetti and Ogle 2000, Smith et al. 1996, van Liere et al. 1996). The use of rapid appraisal procedures and participatory techniques in field research in health has grown stronger in recent years (de Koning and Martin 1996). In the area of rural development and in farming systems research, the conceptual and methodological importance of involving the “researched” more in the research process are well described in Chambers' work over the last two decades (1983 -1997). Both these streams of methodological development and applied ethno-botany methods have provided important complementary tools, or alternatives, to conventional research approaches in nutrition (Cunningham 2001).

In our study, rapid appraisal techniques were particularly useful in the initial phase for familiarising ourselves with people and the study sites, and identifying, in a relatively short time, the species used, the variation between sites in the species used, and their different uses (Paper I). Involving the community members actively through different techniques created a wide interest in the topic among community members as well as the research team and brought out discussions of the multiple functions of many species. Throughout the research it was also through the use of semi-structured interviews with groups and key informants that we could cross-check information and increase the credibility of our findings and interpretations (Pretty 1993, de Koning and Martin 1996).

### **Knowing or consuming?**

However, widespread knowledge of edible wild plants does not provide much information on their nutritional significance. An important further step towards the understanding of the importance of wild vegetables in comparison to other vegetables was possible through the 1yFFQ (Paper I). Other studies have shown the usefulness of this method in frequency distributions and ranking of the importance of individual species (Ogle and Grivetti 1985). In particular our surveys illustrated the widespread and frequent use of a smaller group of “popular” or “major” species, the infrequent use of at least half of the species known, and the difference in relative reliance on wild versus cultivated species in the two regions. The 7dFFQ survey later showed similar results in terms of the species used.

### **Caveats in dietary assessment methodology**

To assess the significance of the wild vegetables in micronutrient intake it was necessary to relate the intake to the overall diet. The 7-day FFQ method that we used in all the sites has been applied to field studies elsewhere to evaluate short-term dietary intake (Eck et al. 1991, Uiso and Jones 1996). In Paper II we have discussed methodological aspects of dietary assessment methods and described how we have dealt with known methodological weaknesses. These include first the quantification of usual serving size, as we needed to use household measures for many of the food items or in some cases calculate individual consumption on the basis of household consumption units (FAO 1990). Other sources of error lie in conversion of raw foods to cooked foods and the calculation of nutrient intake on the basis of available food composition data. We have paid much attention to this step in the analyses by making use of the conversion tables used at NIN, Vietnam, and test-weighing edible portions.

Another limitation lies in the use of composition tables where most values are for raw food items only. This is a problem that is common to most food composition tables used in low income countries and thus is a limitation for interpretation of dietary data in the developing world in general.

Interestingly the mean intakes of major food items and food groups are relatively similar to those previously reported in Vietnam (Paper II). Differences may partly be explained by methodological differences and by changes in consumption over the last decade. We may also have introduced more precise estimations through the probing for further details. The validation of the dietary intake data through the calculation of BMR factors indicated that the percentage of respondents who under-reported was relatively low and similar to many other dietary studies (Schoeller 1990). Additionally the biochemical parameters that we included i.e. haemoglobin, serum ferritin and serum retinol can serve as some kind of basic indicator of the reliability of the data even if they do not reflect current intake only (Jacques et al. 1993).

### **The nutrient content of wild edible plants**

In Paper III we have shown that many of the commonly used wild vegetables in the study areas have higher than, or equally high concentrations of carotenoids, calcium, vitamin C, folate and iron as available cultivated alternatives. A number of researchers before us who have studied edible wild plants have reported on such species (Table 3). Yet such information is of limited value unless it is possible to link the data to dietary intake data to determine whether the quantities consumed are sufficient to make a difference in the overall intake. Considering the vast number of wild vegetable plants known and the geographical and socio-cultural variation in use, it would be necessary to select the species for analysis on the basis of dietary intake studies. A useful initial screening may be to carry out a food variety analysis on already existing dietary intake data from different regions and follow up the findings using a combination of RRA/PRA techniques and laboratory analyses.

### **The nutritional significance of wild edible plants in the diet**

Through our research studies we have shown that edible wild plants continue to provide important nutritional contributions to women in all the study areas in a number of ways. The initial study illustrated that wild plants added considerably to the variety of vegetables consumed and were commonly used in parallel to the use of cultivated and

commercial vegetable species (Paper I). A majority of women made use of wild vegetables and many used wild species in larger quantities than cultivated or commercial varieties (Paper III).

Wild vegetables contributed significantly to micronutrient intakes, especially vitamin A, vitamin C, calcium and folate intakes, but also to the intakes of iron and several other micronutrients (Paper II-V). Most of the plants described in this study are green leafy vegetables. Thus they belong to a vegetable category that often is referred to as an excellent source of many micronutrients but also a category where bioavailability, especially with respect to vitamin A and iron must be questioned (de Pee et al. 1995, 1996). Our research indicates that the contribution of  $\beta$ -carotene from green vegetables, in a mixed and diverse diet as the one in our study areas, is considerable even when an equivalence ratio of 26:1 is used (Paper III, Fig 2). The contribution of wild plants to iron intake is more difficult to interpret as it must reflect also the presence of modifiers in the diet, both enhancers, such as meat, fish and vitamin C, and inhibitors, such as phytate or tannins (Allen & Ahluwalia 1997, Benito and Miller 1998, Brune et al. 1992). With respect to enhancers it is important to note the high vitamin C intakes and the relatively diverse diets in our study population, and that the majority of the women included fish or meat in their diets (Paper IV). With respect to inhibitors we have discussed the potential adverse effect of tannins and phytic acid in some of the wild vegetables in Paper III but we were not able to analyse the levels of these in other dietary components e.g. cereals, vegetables in general or tea.

In the Mekong Delta studies we were also able to illustrate the importance of a seasonal analysis in the evaluation of the nutritional significance of wild edible plants (Paper II). Ideally a survey at the peak of the dry season in both the Mekong Delta and the Central Highlands would have strengthened our understanding of the seasonal cycle of wild plant contributions to nutrition. It would also have made possible an analysis of the value of the more widespread home-gardening practices in the Central Highland sites (Paper I, Table 1).

Another important aspect of dietary importance of wild plants that is indicated in this thesis is the variation between different ethnic groups (Paper I and IV). Such socio-cultural variations have also been reported elsewhere (Scoones et al. 1992). In Vietnam,

many of the minority groups have experienced rapid changes in their livelihood systems in the last decade. The groups we have analysed are few and the sample size is too small to allow wider interpretation, but the data suggest that it would be important to analyse the nutritional implications of this transition including an analysis of changes in the use of traditional foods.

### **Food diversity, nutrient intake and health status**

One of the objectives in this research has been to evaluate the association between edible wild plants, food diversity, and nutrient intake and health status. In Paper IV we have shown that traditional foods, both edible wild plants and indigenous fish species contribute considerably to the overall diversity of the food basket and to the nutrient intake of the study population. It is important to note that the groups with the highest food variety scores had relatively adequate intakes of most of the nutrients included. However, the analysis of nutritional significance of the wild vegetables to the study population is only partial, as relatively few nutrients were analysed. An evaluation of the potential value should consider not only the contribution of other nutrients with known physiological functions but also the potential benefit of phyto-chemicals through the traditions of therapeutic uses of edible plants. Paper I raises such questions but we were not able to quantify therapeutic uses or probe into women's views on the importance of these traditions. It is however an area of current research interest and one that in the Vietnamese context deserves more attention.

### **What factors promote, restrict or endanger future use?**

Many conflicting forces affect people's ability and decisions to continue to utilise edible wild plants. Demographic changes, intensive agricultural development, deforestation, resettlement and wars are often cited as underlying causes of a decline in use of edible wild plants (Wood et al., 2001). Thus it is interesting to illustrate through this thesis that even in such situations edible wild plants continue to be part of the diet. Several factors are likely to contribute to this. In the Mekong Delta, sites of the greatest abundance were dykes, edges of fields and surroundings of the homesteads, where it was convenient for

women to gather plants. Vegetable production was difficult due to acid soils and recurring floods and the economical returns of home gardening were low.

*"Vegetable production is good for old people who can't work hard and earn a higher income"*(citation women in Mekong Delta)

In contrast the Central Highlands sites illustrate how changes in livelihoods can lead to a decline in the use of edible wild plants. Such development has been shown also elsewhere in connection with policy changes (Saowakontha et al. 1994). In the Central Highlands sites resettlement schemes have encouraged settled farming for minority groups and lowland households to migrate to the area, and production of rubber, fruits and cinnamon was subsidised. Home gardening was nearly universal. It is interesting to note that also in this setting women continued to complement their production with wild vegetables, although at a lower level.

The cultural appreciation of many wild species is an important factor in their continued use. In the wider context of local uses of non-wood products Perez has observed that gathered products cannot be treated as a homogenous group but that integration into social and cultural identity, labour and time demand and lack of alternatives are important determinants of continued use (Perez 1995). This is applicable also to the narrower use of gathered food products. The dual role of many vegetable species in preventative and curative health care is a strong aspect of cultural identity that is likely to support continued use, as has been shown elsewhere (Etkin and Ross 1982-94). Additionally, the reliance on *Rau Dai* in war times and crisis, although it may add to the stigma and low status attached to some species, has also kept alive and widespread the information and knowledge on the usefulness of edible wild plants.

## CONCLUSIONS

The majority of rural households in the study areas continue to use edible wild plants in their diets and these make important contributions to the nutrient intakes of women. Failure to observe these in dietary assessments can significantly underestimate intakes of a number of nutrients especially vitamin A, folate, calcium and vitamin C but also iron, thiamin, riboflavin and niacin.

Several of the species have high concentrations of pro-vitamin A carotenoids, folate and some minerals. Lack of reliable data on the chemical composition of edible wild plants is a major constraint in evaluating their significance in current diets and thus the decision whether to include them in dietary recommendations.

Edible wild plants add considerably to dietary diversity and women with the highest food diversity had relatively adequate diets. A food variety analysis can be a useful screening tool in identification of groups with more inadequate diets.

Many conflicting forces affect people decisions whether to continue to include gathered vegetables in the food basket. Traditions, convenience and the dual role of many species as vegetables and in therapeutic and curative health care are factors that positively affect women's decision.

Evaluation of the dietary role of wild edible plants requires special methodological efforts for several reasons. Their use can be highly site specific and varies with agro-ecological conditions, local food traditions and ethnicity. Several local names may be used in the same area and as plants often are known only by their local names, botanical identification needs to be included in an assessment. As composition data often is lacking or unreliable, nutrient analysis or use of substitution values may be necessary.

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