

SESSION 1 TOPIC: Typology - Characterization – Inventory list
Application of Community based methodological approach for the characterization and impact of informal irrigation systems in two sub-districts of Ethiopia – R.D. Bekele

In most parts of Africa, small farmers' livelihood security is strongly dependent on the distribution and unsustainable land management practices. Over 95% of agricultural production is based on rain-fed system which appears to be enabling to provide sufficient food for the rapidly increasing population (Rockstorm, 2000). Therefore, irrigation projects which offer increased and much needed food production possibilities and provides other benefits such as generating rural employment opportunities. Informal irrigation which covers a substantial extent of land, managed by farmers themselves (operation and maintenance of hydraulic infrastructure, financing and decision making about the crop pattern, physical and institutional layout of the scheme) is gaining much attention. Even though its contribution to food security is important, information about such kind of irrigation systems is poorly documented.

The main goal of the current study is to propose a sound and affordable methodology to establish a standardized national inventory system of informal irrigation. Two study areas namely Atsbi Wemberta sub-district in Tigray region and Ada'a sub-district in Oromiya region have been selected to demonstrate the application of community based methodological approach for the characterization and impact of informal irrigation systems in the research.

The paper first proposes a community based survey of 23 informal schemes managed by 169 farmer groups. Characterization of water use system as well as assessment of informal irrigation impact on the community welfare improvement has been conducted. Secondly, the results obtained are related to cost and benefit accrued by beneficiary farmers in year 2006/07.

For each sub-district, the participatory approach used has involved farmers in the identification, determination and analysis of characteristics of the community managed irrigation schemes: scheme name, irrigable area(ha), actual irrigated area (ha), the ratio of irrigated area(%), number of farmers in the scheme, name of the water source, average area per household, the type of crops grown and coverage area (ha), types and rates of input used, the mean crop yields (kg/ha), average price of each crop, structure of irrigation administration (including the formal and informal ones), organizational framework, financial and managerial structure including the regulatory apparatus and conflict resolution mechanisms which are directly connected to the water use (appropriation and provision of irrigation water). Finally, the net-revenue of each crop type grown in the informal irrigation scheme in the year 2006 is calculated.

Based on the information provided by farmers for the year 2006/07 cropping season, in Atsbi, the informal irrigation system has over 221.1265ha of land coverage, with 1855 number of beneficiary farmers. On the other hand, in Ada'a, the total area under cropping is 960.5ha of land with 2059 beneficiaries. In both study areas, each irrigation scheme is a common property resource with its own water users association and water users committee. Each scheme is divided into 3 to 31 sectors according to the landscape. The number of households per sector(group) varies from 7 to 497. The number of household groups defined for administrative purpose by the farmers themselves, is 94 in Atsbi and 75 in Ada'a.

The groups have their own written by-laws which includes a penalty system. In view of a communal management of the informal irrigation scheme and in accordance to the written

by-laws, each farmer is required to contribute, in cash for an amount of 1.3 US\$ for the payment of guards who protect the schemes (croplands and infrastructure) and for expenses related to minor constructions). The farmers are also contributing in kind (stones and white soils) and in labor (maintenance and clearance of canals).

In addition, the survey revealed that the farmers have started to growing cash crops which were not previously grown in the areas such as onion, garlic, tomato, potato, cabbage, peas and beans. This has resulted in an increased nutritional conditions and welfare of the household: on average a household income has increased by double and 30% of them could send their children to school.

Finally, the study pointed out that, even though the community managed informal irrigation schemes have been operated well in both woredas, more attention should be given to strengthening of farmers organizations and institutions as well as the management of water resources. In addition, effort should be made to supply improved variety of seeds to farmers, to diversify their crop production and gain more benefits.

Estimating crop yields in flood recession agriculture in the Senegal river valley using Remote Sensing and GIS. L. Mane and P. Fraval

In the Senegal river floodplain, irrigated agriculture and traditional flood recession crops (mainly sorghum) coexist. The latter depends upon the extent of the annual flood, which is partly a function of the amount of water released from the upstream Manantali reservoir. Even though recession sorghum yield is clearly smaller than that of irrigated rice, this production system, because it covers a large area, is a major contributor to total food production in Podor and Matam departments. It is therefore important to quantify areas and yields. In collaboration with the West Africa Rice Development Association (WARDA) and the International Water Management Institute (IWMI), SAED has carried out a survey of the 2000-2001 agricultural campaign based on remote sensing and GIS analysis.

In 2000, inundations in the Podor department covered 37.635 hectares. 3.277 million m³ of water were released from the Manantali reservoir specifically to support the natural flooding due to uncontrolled tributaries of the Senegal river. However, over the entire rainy season, the inflow into the reservoir exceeded the water released from it.

In the Podor department, 18.998 hectares were cultivated, corresponding to 51% of the inundated area. In total, in both departments, the total area under sorghum cultivation amounted to 25.745 hectares in 2000-2001, that is only 44% of the area of the previous season, particularly wet. The total production of recession sorghum grain in the Matam department is about 4.075 tons and the average yield 638 kg/hectare.

The method used gives reliable results, particularly a good relationship between yield and spectral response. It requires not more than 3 weeks of fieldwork but timing is crucial. Coupled with SAED's Geographic Information System (GIS) and complementary to the survey of rice production using remote sensing analysis, this work provides a more accurate estimation of food production at the level of each Rural Community. It also provides objective information to assess the mutual influence of recession sorghum and irrigated rice cropping systems.

Locating irrigation typologies: spatially disaggregated informal irrigation maps of Nigeria. O.I. Oladele, A.I. Adeoti and A.K. Braimoh.

This paper proposes a sound and affordable methodology for inventory and characterization of informal irrigation practices in Nigeria. This is predicated on the fact that a substantial proportion of the agriculture practicing population is supported by informal irrigation and Nigeria consists of all the agro ecological zones in West Africa. Other non-agricultural livelihoods are also attached to the informal irrigation sector which appears often spontaneously in the urban, peri-urban and rural areas. Many generalized attempts have been made to enhance the informal irrigation, but it is well recognized that geographic targeting as opposed to across the board-based intervention is more effective at maximizing the coverage of the end-users. The methodology will combine exploratory (surveys and interviews), mapping and irrigation policy review.

Geo-referenced informal irrigation maps when integrated with more conventional sources of information will help identify the irrigation typologies and assist in characterization that is location specific. In informal irrigation mapping the choice of indicators related to the different dimensions of informal irrigation will be covered in terms of the economic, social and enabling environment. The unit of analysis will be Local Government Areas (council), the level of administration where the reality of informal irrigation can be captured in the most detailed manner. The characterization will be based on user factors, socioeconomic, environmental and technical factors. These factors will take cognizance of crop types, farm sizes, water sources and inputs from national agricultural census data. Irrigation typologies based on crop types will be super imposed into the agro ecological maps. The expected output will be to generate informal irrigation maps of Nigeria and spatial distribution of informal irrigation in Nigeria

Use of low altitude air photos for the follow-up hydro-agricultural activities – Case of the Kou basin. J Wellems, M. Diallo, D. Dakoure, N.F. Compaoré & B. Tychon

The Kou basin, located in the south-west of Burkina Faso, has been for a few decades object of various forms of conflicts related to a whole series of problems which one encounters generally in irrigated areas.

In the Kou basin, the listed hydro-agricultural developments cover a total surface of almost 3,200 ha ; they are essentially private perimeters forming the Market-gardening and horticultural belt of Bobo-Dioulasso and a large perimeter of 1,200 ha carried out by the State at Bama and specialized in rice production . The development of a fruit and vegetables sector under the impulse of private initiative is a characteristic feature of irrigated production in the area.

In addition to water abundance related to the presence of important sources, an easily exploitable ground water, a perennial river and a sub-wet rainy season, the majority of water users regularly experience water shortage because of an increase in population and an intensification of irrigated agriculture.

This leads the basin managers to seek control and follow-up tools .

From more than 300 “amateur” air photos at low altitude, having a 0.9 m resolution, a detailed map of land occupation could be elaborated. Software of mosaïquage, of image processing and of GIS allowed the construction of a unique georeferenced image. Agricultural plots were delimited afterwards. the plots and their occupation were compared and supplemented with the results of an exhaustive hydro-agricultural census organized at the same moment.

This technique allows a space follow-up of the agricultural activities at lower cost compared to the acquisition of high resolution satellite images. The approach is also less sensitive to the non-foreseeable atmospheric influences in the programming of the satellite images. “unmixing” algorithms of MODIS images and follow-up of soil surface moisture, are to be developed for the development of water assessments.

Key words: air photos, water management, agriculture, land occupation, remote sensing, GIS, agricultural census.

Market-gardening production and irrigation system in the town of Cotonou: cartographic approach (Benin) –

In the Benin agriculture, truck farming occupies a relatively important place by its contribution to food security. The objective of this study is to carry out the analysis of the irrigation system used as regards market-gardening production in the town of Cotonou.

Investigations in real medium, the Routing Method and the Accelerated Method of Participatory Research (MARP), made it possible to collect information near the targeted stakeholders. Bibliographical analysis, individual discussions with market-gardeners of Cotonou, technicians of the Regional Centers for Agricultural Promotion helped apprehend and evaluate the potentials of the town of Cotonou in market-gardening space as well as the problems of irrigation spaces. The cartographic approach was used for the representation of the distribution of market-gardening perimeters according to the irrigation systems

The analysis of the results shows that market-gardening perimeters are unequally distributed in the town of Cotonou. In addition, several irrigation systems are used in the direction of the efficient and effective use of water for market-gardening production of the town of Cotonou.

The results of this study will contribute to decision-making and will contribute to take steps aiming at improving the irrigation systems in progress on the sites and to equip producers with a space developed for sustainable market-gardening production in the town of Cotonou.

Key words: Cotonou; irrigation system; market gardening; cartographic approach.

Market-gardening production and irrigation system in the town of Sèmè-Kpodji: cartographic approach (Benin)

In the Benin agriculture, truck farming occupies a relatively important place by its contribution to food security. The objective of this study is to carry out the analysis of the irrigation system used as regards market-gardening production in the Commune of Sèmè-Kpodji.

Investigations in real medium, the Routing Method and the Accelerated Method of Participatory Research (MARP), made it possible to collect information near the targeted stakeholders. Bibliographical analysis, individual discussions with market-gardeners of Sèmè-Kpodji, technicians of the Regional Centers for Agricultural Promotion helped apprehend and evaluate the potentials of the Commune of Sèmè-Kpodji in market-gardening space as well as the problems of irrigation spaces. The cartographic approach was used for the representation of the distribution of market-gardening perimeters according to the irrigation systems

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Key words: Sèmè-Kpodji; irrigation system; market gardening; cartographic approach.

SESSION 2 TOPIC: Technical, institutional and organisational aspects of Urban agriculture and structuring of the urban environment in Burkina: Analysis of the role of farmer organizations and agricultural professional ones – D. Ouedraogo

Urban and peri-urban agriculture (AUP) plays an important role in the large cities of Burkina. It contributes to improve the nutritional status of the urban populations, and represents the principal source of income for the vulnerable population. However the AUP is confronted with several types of risks (climatic changes, land tenure, health and price changes). Vis-a-vis this situation, farmer and agricultural professional organizations develop strategies of adaptation, thus contributing to structure the urban environment as well on the physical level as on the institutional one. The objective of this study is to analyze the role of institutions in the construction of the urban landscape of Burkina. For this purpose, we collected quantitative and qualitative information near the various stakeholders of the AUP (individual producers, groupings, associations, co-operatives, engineering departments and financial ones). The principal results reveal the presence of a varied range of formal and nonformal institutions which contribute significantly to the management of the urban environment. Several activities relate to domestic waste recycling and agricultural good practices and irrigation which mitigates negative externalities on populations' wellbeing. Moreover, these institutions take part in the improvement of the human capital with induced effects on the adoption of good practices, productivity and products quality. They also support the dialog between stakeholders and thus mitigate tensions related to land insecurity. In the current context of decentralization, municipal authorities should be based on these institutions as stakeholders impossible to circumvent for a better integration of agriculture in the city planning.

Key words: Urban agriculture. environment. externality. risk. institution.

Analysis of the determinants of the adoption of good practices of irrigation in urban and peri-urban agriculture in Burkina: Case of market-gardening in the towns of Bobo-Dioulasso and Ouagadougou - L.M. Kinane, T.A. Tougma, D. Ouedraogo, and M. Sonou

Informal irrigated agriculture, in particular urban and peri-urban market-gardening, contributes to food security and the fight against poverty in Burkina Faso. The need for producers to adopt better irrigation practices vis-a-vis the inappropriate use of worn water is essential, on the one hand for the protection of their health and that of market-gardening products consumers and on the other hand for the very survival of this activity. This study has as a principal objective to understand the factors which affect the adoption of an irrigation system currently used by producers and of which financial profitability was proven by a former study. This in order to better formulate proposals for the gradual improvement of the use of better practices of irrigation in this sector. The study was based on data collected near 700 urban and peri-urban market-gardeners in Ouagadougou and Bobo-Dioulasso. The irrigation system studied consisted of river, motor-driven pump, storage tank and watering-can. The logistic analysis shows that the social status of the producer and the number of years of practice of market-gardening support the adoption of this system. Moreover, cabbage culture positively influences the probability of adoption of the aforesaid system. The more the producer perceives the scarcity of water resource, the more he is willing to adopt this system. On the other hand, the size of the acreages constitutes a major obstacle to the adoption of this irrigation system. Access to credit and membership of a farmer organization do not seem to constitute factors determining the use of this system. These results confirm the need for better securing the land statute of the producers in any action of improvement of irrigation practices. These actions will have to also take into account the type of culture to be encouraged/discourage according to the irrigation system. A sensitizing of the producers on the future difficulties of access to water resources would support the change towards better practices.

Key words: Informal irrigation, adoption, good practices of irrigation

Determinants of the sustainability of irrigation practices in urban and peri-urban agriculture in Burkina: An approach in terms of effectiveness and financial profitability - T.A. Tougma, D. Ouedraogo, L.M. Kinane, and M. Sonou

The development of an informal irrigated agriculture dominated by the market-gardening contributes to food security of the African cities, and the improvement of the economic situation of vulnerable and marginalized quintiles. But the many problems with which urban and peri-urban agriculture is confronted reduce the capacity of certain poor households to satisfy their essential needs. It then raises the thorny question of the sustainability of this activity in relation to the associated practices and risks. The present study proposes to thus analyze the sustainability of irrigation practices by taking account of the effectiveness in the combination of resources and financial profitability. We simultaneously used the analysis of operating statement of market-gardeners and an analysis of production function of the Cobb-Douglas type. The data for the implementation of the models were collected from 700 market-gardening producers in Ouagadougou and Bobo-Dioulasso, on 12 sites of production. Our results support that the system using river, motor-driven pump and watering-can financially proves to be a good irrigation practice since more effective and profitable with a gross margin of 890.000 FCFA. The linear regression of the logarithmic curve of the function of production reveals that the use of this system increases the output of 0,8%. This system reduces the watering time and the painfulness of work related to water pumping out, thus making it possible to increase the level of the production by a better valorization of the production factors .

Key words: Urban and peri-urban irrigated agriculture, sustainability, effectiveness, profitability, good practices of irrigation.

Characteristics of Small Scale Irrigation Technologies in the White Volta sub-Basin, Ghana - Eric Antwi Ofori, Pieter van der Zaag, Nick van de Giessen, Samuel Nii Odai and Amaury Tilmant

In sub-Saharan Africa, the technological improvement of rainfed agriculture and the up-scaling of small-scale irrigation are seen as major ways in alleviating poverty, achieving the MDGs and improving economies (GPRS, 2003). The Government of Ghana since 1951 has invested in the construction of small reservoirs, large reservoirs and dugouts for irrigation purposes in the semi-arid Northern Regions of Ghana. Most importantly, within the past fifteen years, the prospects of horticultural production (onions, tomatoes, pepper and leafy vegetables) has made dry season irrigation one of the major economic activities of farmers and has also introduced other irrigation technologies such as shallow wells (temporal and permanent) and riverine irrigation with different water lifting mechanisms. These prevailing irrigation technologies have varying characteristics ranging from physical, spatial, financial components, management, water-use, land-tenure, gender participation to economic productivity. The **comparative knowledge of these characteristics** is very essential for decision makers in the promotion of irrigation technologies and the up-scaling of irrigation in the White Volta basin. The research collected information on dry season irrigation farming from three sub-catchments (Anayari, Atankwidi and Yarigatanga) of the White Volta sub-basin in the Upper East Region of Ghana from October 2007 to April 2008. Out of 85 farmers selected 53 of them provided reliable data for analysis. The data collection ranges from **farm size, farming practices, daily farm costs, water-use, watering costs, harvesting data, organizational activities, years of experiences, marketing and etc.** Tomato is the main crop investigated under the various irrigation technologies. The measured farm sizes for small reservoirs ranges from 0.008 – 0.91ha, 0.1 – 1ha for riverine alluvial dugouts, 0.3 – 0.8ha for riverine water 0.125 – 0.64ha for large reservoirs, 0.006 – 0.035ha for the temporal shallow wells and 0.005 – 0.020ha for permanent shallow wells. The study assesses the **operation costs of the irrigation technologies** and classifies them under water, land, labour, nutrients and seeds. Comparatively, the results show a wide variation in the operation cost components for the irrigation technologies. Averagely, the major cost component of permanent shallow wells and small reservoirs is nutrients and seeds (approximately 90%), while that of riverine water and alluvial dugouts is water (approximately 45%). An assessment on the economic yield (marketed yield) shows that on the average small reservoirs made the highest profit of \$1384/ha, while large reservoirs and riverine alluvial dugouts made profits of \$194/ha and \$569/ha respectively. While favorable agreements are made with landlords in the development of small and large reservoirs, the same cannot be said for other technologies such as shallow wells whose capital investment are relatively cheaper. The prevailing land tenure system results in a yearly capital investment in infrastructure for temporal shallow wells and also reduces the potential of up-scaling this technology.

Urine – An untapped resource for vegetable production: a Nigerian study. A. O. Cocker, M. K. C. Sridar, G. O. Adeoye, A. J. Opeyemi and E. O. Oloruntoba

Interest in urine as a resource is gathering momentum in recent years. Its separation and use has emerged as a result of over exploitation of fresh water resources and enormous wastage that goes with transporting human waste through flush toilets and other uneconomic activities. This study is a part of an ongoing project at the University of Ibadan, Nigeria on urine harvesting and utilization in south west Nigeria. Urine collected from a students' hostel was diluted with tap water in the ratio of 1:6 and stored in two 120 l plastic drums. The drums were placed above the ground surface at a height of 0.83m to maintain a head. The experimental plots made up of raised ridges measuring 3m long x 1.5m wide x 0.30m high system were then irrigated by gravity. Similarly, another drum was provided for the release of tap water which acted as control. Green amaranth (*Amaranthus chlorostachys*) planted on loamy soil was irrigated with the diluted urine at the rate of 100l, twice daily (morning and evening) and the plant growth parameters, viz. plant height and number of leaves were measured and compared between the control and the experimental. The results using paired samples t – test at probability of 5%, indicated that no significant difference occurred between plant height and number of leaves of the two treatments at week 1. But subsequently, there were significant differences with urine treated plots.

Urine is a valuable untapped resource which has ready application in urban or peri-urban agriculture. The fertilizing effect of urine is similar to that of nitrogen rich chemical fertilizers and therefore should be used similarly. Past experiences in Nigeria and collaboration with other countries (Sweden, Germany and Denmark) through personal visits by one of the authors has shown that many organic farms have evolved around communities who utilize their own wastes including urine. Urine separation toilets have also become popular and many are adapting to them in their housing designs.

Techniques that could be employed to reduce loss of ammonia during application may include: mixing urine into the soil as quickly as possible; applying urine in furrows or holes, which are then covered over immediately after application; or applying water after urine. Whatever the mode of application may be, the objective is to minimize nitrogen losses, keep the environment free from odours and safety of crops from chemical burns and possible pathogens. It is not necessary to dilute the urine before application. However, the root system of the plant should not be soaked with undiluted urine, as this might be toxic and even lethal, especially for growing tender plants. Instead, the urine should be applied either prior to sowing/planting or at such a distance from the plants that the nutrients are within reach of the roots but that they are not soaked.

Nigeria is a country of diverse culture and beliefs, therefore our group is continuing promotion of urine utilization and collecting data on effect of storage, pathogen survival, application rates, nutrient losses, and irrigation technologies.

Irrigation technology in South Africa, within a global context – F. Reinders

**SESSION 3 TOPIC: Contribution to food security and poverty reduction
Estimate of water economic value in urban and peri-urban irrigated agriculture in Burkina: A lighting on market-gardening producers assent to pay (CAPE) for quality water in Ouagadougou and Bobo-Dioulasso**

the provisioning of households in vegetables in the majority of African cities is primarily assured by urban and peri-urban irrigated agriculture (AUP) . In the majority of cases, the vegetables are irrigated with worn water or of poor quality coming from dams, rivers or draining canals which collect water from slaughter-houses, breweries, oil mills, hospitals and households. Taking into account the availability of this water and sometimes of its fertilizing value, it is used by producers in a rough state in spite of the many medical risks. In addition, the costs of exploitation of worn water are relatively weak and even perceived by some producers as null. An improvement of the water quality used in AUP, and consequently of the products, requires the setting up of irrigation water purification systems. From this point of view, our study aims at evaluating producers assent to pay for an improvement of water quality in market-gardening systems of production. In the absence of “market of treated worn water ” in AUP, we had recourse to the method of contingent evaluation . We chose to combine the method of double closed questions and that of open question to allow producers to reveal with more honesty their assent to pay. The results reveal that more than half of the producers are favorable to the implementation of systems suitable for the increase in water quality used for market-gardening production. They are ready to pay on average 53,72 F CFA to profit from one cubic meter of treated water.

Key words: Urban and peri-urban agriculture, economic value, assent to pay.

Perception and risk management in urban and peri-urban irrigated agriculture in Burkina: Empirical instances in Bobo-Dioulasso and Ouagadougou

Urban and peri-urban agriculture (AUP) plays an important role in the improvement of the living conditions of the most vulnerable population in African cities. It contributes to improve their nutritional status and often constitutes their principal source of income. But beyond its real or potential advantages, the AUP involves important risks as well for producers as for consumers of market-gardening products. With the resurgence of certain hydrous diseases in urban environment and urban expansion which accentuates constraints on producers, the debate on the AUP took a new dimension during the last decade, with regard to the complexity of the situation. Under the assumption that a better knowledge of the risks to which the producer is exposed can lead him to adopt good strategies of adaptation, we undertook to analyze the perception of the risks and their modes of management in market-gardening production systems. Our results show that producers face several types of risk (medical, climatic, economic and land-related) whose interactions negatively affect their wellbeing. Approximately 14% of the producers are truly aware of the medical risks to which they are exposed and expose consumers by using used water to produce vegetables. On the other hand, the majority of market-gardeners well perceive the risks of expulsion, the price risks and the climatic risks . But the strategies implemented appear ridiculous and do not allow an efficient management of the risks. The policies of urban development must take account of these aspects insofar as negative externalities related to the AUP are reflected along the sector and pose serious problems of public health.

Key words: market-gardening, perception, risk, strategy, risk management.

Market-gardening production in the town of Niamey (Niger): developments and impacts on populations

The fresh vegetable supply in the town of Niamey is partly ensured by the sites of production located in and around the city. These sites which knew a progressive increase during years are fed out of water from the Niger River, from wells and sumps dug to this end but also by worn water of the city.

Within the framework of its (perished) - urban irrigation activities promotion without medical risks, the of the United Nations Food and Agriculture Organization (FAO) granted to the National Institute of Agronomic research of Niger (INRAN) a financial support in order to undertake a study entitled “study of the bio-contaminants and migration of toxic agents in intensive irrigated market-gardening in the city and the periphery of Niamey”. The study related to six sites, presenting various market gardening production conditions inside and at the periphery of the town of Niamey.

the work consisted of an inventory of the surfaces per culture on the whole of the sites, of the physicochemical analysis of soils, water and products, bacteriological analysis (bio-contaminants), experimental tests on 2 sites (Gountou-yéna and Saga-basin) and investigations near market-gardeners, consumers and medical centers on the quality of market-gardening products.

The present communication proposes to restore the results of this study in terms of evolution of surfaces development, of water quality used for market-gardening production like in terms of impacts not only on consumers but also on producers.

The results of this study show different farming intensity according to sites'. In urban sites like Saga-basin and Gountou-Yéna, the farming intensity is respectively 130% and 162%. For the peri-urban sites, the farming intensity is low. In Goudel Gorou and Saga-Gorou II where irrigation is done from ponds, it is 80% while in Saga-Gorou I where water is drawn from wells, it is only 17%. The evolutions of surfaces development know a fluctuation according to sites'. In general from 1999 to 2003, one notes an evolution of surfaces of the peri-urban sites which would be located around 38,5%; and that of urban sites would be of - 33%.

Concerning the characteristics of water used and soils emphasized, one notes that water, concerning all the sites, is free from streptocoques fecal. However coliformes fecal was detected with a strong infestation in water of the river upstream the city. Concerning soils, the bacteriological analysis of the samples show that upstream the city, they contain the streptocoques and coliformes. Concerning heavy metals in particular lead and cadmium these analyses showed that cadmium is present only in the form of trace whereas lead , was detected. The content relatively higher of the soils of saga-basin could be explained by its position in industrial park and downstream the city.

The study also showed several failures in the production of these cultures. These failures relate to the precautions to take during the plant health treatments, spreading of manures and also during irrigations. All these failures have a negative impact on producers' health. Apart from the owners, the study also revealed tha the conditions of production of these cultures are not without consequence on consumers' health.

Private developments in the Senegal River delta: difficulties of drainage and environmental problems

The advent of the New Agricultural Policy (NPA), adopted by the Senegalese State in 1984, completely transformed the institutional context of agricultural development in the delta and the valley of the Senegal River. The transfer of competences to Rural Communities (CR), the

startup of the dams (Diama, 1986, Manantali, 1989), the presence of CNCAS 1^[1], inter alia, involved a rush towards water and land. The stated objective was the emergence of a new type peasant, empowered and controlling the technical routes. From 1987, a profusion of private developments, carried out summarily took place along the hydraulic axes radically modifying the agrarian landscape of the delta. With more than half of cultivated surfaces, private developments considerably contribute to local rice production. This surge of private irrigated perimeters (PIP) is not without consequences on the biophysics environment and threaten even ecological balance of the area.

The objective of this study is to appreciate the extraordinary development of private irrigation in the delta of the Senegal River and finally the environmental impacts of the discharge of drainage water in nature. Proposals are made at the end for a sustainable development of private perimeters irrigated in the delta of the Senegal River.

Key words: New agricultural policy, transfer of competences, private developments, biophysics environment, ecological balance, delta of the Senegal river

National Fund of Agricultural credit of Senegal

Informal irrigation and development of the southernmost slopes of the mounts bambouto (west-Cameroon)

The Bambouto mounts are in the high plateaus of West-Cameroon. They constitute an enormous solid mass, the most important volcanic building of the volcanic tectonic line of Cameroon. These mounts also constitute the second water tower of Cameroon after Adamaoua. It is actually about an area with plural natural assets. Pedology is particular there, a not very acid, thick and volcanic soil. Water runs out there from the high lands towards low altitudes but however, the number of junctions and the length of the hydrographic network lower upstream towards downstream. One counts in the southernmost slope seven rivers but which runs with an irregular mode according to seasons.

These incomparable assets made Bambouto mounts a zone particularly coveted for agricultural activities, practiced on strong slopes (more 20°). One counts there thousands of owners, originating in the villages of Bangang, Balatchi, Bafou, Balépo, Bamock... The principal agricultural activities are the culture of cereals, the tubers, leguminous plants and especially of market gardening. These activities are made possible, in period of rise as in period of low water level, thanks to multiple endogenous techniques which are the collecting of water and irrigation. Whereas some affluent peasants use motor-driven pumps for a viable supply of their plantations, a considerable majority remains in precarious and informal irrigation practices. The latter practice, either irrigation by sprinkling, or they proceed by a “*diversion of the rivers*” in order to ensure in their plots an irrigation of surface, or they use pipes of collecting starting from upstream towards their downstream located plantations or with the piedmont. These practices of local irrigations are nowadays of an indisputable importance in the agricultural production of the rural people. Thanks to them, many peasants produce on the southernmost slopes tons of land apples, carrots, cabbages, onions, sugar beets, leeks, sweet peppers... This market-gardening agricultural production made Bambouto mounts a true source of supply for the large cities of Cameroon and for the countries of the central Africa sub-region (Gabon, Central Africa, Congo...).

^[1] National case of Agricultural credit of Senegal

Thanks to these informal and rudimentary irrigation techniques, these rural producers of the mounts make possible the accessibility and the availability of many agricultural produce on the local and international markets. They thus contribute in a determining way to poverty reduction and the unceasingly improvement of food security in many localities. These informal practices of irrigation have certainly considerable environmental constraints (upheaval of the hydrous system, pollution of the ground water) but, they constitute an important endogenous potential. They can be improved and capitalized to ensure a true food security and a sustainable local development.

Key words: informal irrigation, market-gardening, Bambouto mounts, food security, poverty reduction, sustainable development

The MUS approach: looking at informal irrigation from a broader perspective.

People in rural areas need water for both domestic purposes as well as for productive activities,. These different uses of water bring different benefits, like improved health, food security and economic benefits. However, water programmes generally do not address these multiple needs in an integrated way, therefore not capitalizing on the full range of potential multiple benefits. Programmes typically have a narrow sectoral focus, seeing the world in terms of water and hygiene related health benefits (domestic use) or food security and economic benefits (productive use). This results in the provision of sectorally biased systems and services. In reality though, people tend to widely use ‘domestic’ systems for small-scale productive uses like small scale gardening, keeping livestock and micro-enterprises, while water from irrigation systems is also often relied upon for domestic uses.

This paper argues that when domestic water supply programmes fail to take productive uses into account, this not only prevents them from having their full potential impact on poverty reduction and livelihoods, but can even have a negative impact on the sustainability of water supply facilities. It puts extra pressure on services when they are under-designed for the real multiple needs that people have. It also leaves users with the responsibility of owning and managing systems that only partially meet their needs, which has negative effects on operation and maintenance. In response to this situation, a number of organizations, including IRC International Water and Sanitation Centre, International Water Management Institute and Plan International, have been developing and advocating for a so-called MUS (Multiple Use Services) approach. This is an integrated bottom-up, pro-poor approach to meeting poor people’s water needs for multiple purposes.

After introducing the MUS concept and approach, this paper will give an overview of the incremental costs and benefits of stepping up the water service ladder towards an integrated MUS approach, both from a domestic as well as an irrigation starting point. This will be based on the results of a recent global study and on a number of detailed case studies from Ethiopia, Zimbabwe and South Africa.

The paper then focuses on West Africa to consider current MUS practices in the region. Finally the paper discusses potential and challenges for wider application of the MUS approach in the West Africa region.

**SESSION 4 TOPIC: Contribution to food security and poverty reduction
Assessment of informal irrigation management in urban agriculture on food security in Lagos**

Informal irrigation scheme managed by urban farmer has increasingly become an important issue in Lagos, because of its perceived benefits which include low cost, availability, accessibility and higher production output in difficult terrain. It has also become important because of its roles in ensuring urban employment opportunities, urban food security and urban poverty reduction among the marginalized including women. Despite these perceived benefits and opportunities, informal irrigation has been associated with the negativities in urban food production and environmental pollution with unquantifiable impacts on the health of producers and consumers. This paper therefore examines extent of informal irrigation management pattern in selected urban agriculture farms in Lagos. It determines factors responsible for the observed management pattern and further relate the management patterns with reported health problems among resident farmers. Ecosystem approach to human health forms the theoretical framework for this paper. It builds on previous theoretical and empirical studies of informal irrigation management activities at regional and local levels. Physiochemical and microbiological analyses of water sources were also carried out using appropriate and necessary methods in addition to observations, face to face questionnaire administration and Focused Group Discussions. The paper concludes that informal irrigation schemes are important resource of water and nutrients for urban food production and the strategies adopted for its management is technically, socially, economically and geographically determined. Although, the different method of informal irrigation management pattern adopted by Lagos urban farmers differ spatially and are aimed at the enhancement of urban food security, its long term effects undermine the efforts put forward by farmers to ensure urban food security due to its unsustainability.

SESSION 4 TOPIC: Development prospects

Participatory evaluation of the drop by drop irrigation technique in the North of Burkina Faso: potentialities, constraints and conditions of adoption – J. Gué-Traoré, V. Tarpaga, S. Soro, Dr A. Tschannen, Dr D. Dao

The extent of the practice of market gardening in the North of Burkina Faso contributes to increase the water requirements, since the traditional systems of irrigation used (gravitating with raits on the ground, by sprinkling or with watering-can, etc), require large quantities of water. This dynamics places market-gardening producers in a kind of dilemma or vicious circle, where the economic stake, while making practice of market gardening, one of the alternatives for survival of the populations, induced, paradoxically, the increase in cultivated surfaces and water requirements, on the one hand, and contributes to accelerate the stranding of the dams whose circumferences are the places of predilection for market-gardening producers, on the other hand. Convinced that the traditional methods of irrigation are increasingly unsuited, limited or inappropriate, in an arid sahelien country like Burkina Faso, and from the “will of change” expressed by four unions of market-gardening producers (unions de groupements Naam de Ouahigouya, de Koumbri et de Tikaré), vis-a-vis the problems of market gardening in the North of Burkina Faso, the Institute of Environment and Agricultural Research (INERA, Burkina Faso), the Swiss Scientific Research Center (CSRS, Ivory Coast), a private company “Optimal Conseils et Services” (OCS, based in Ouahigouya) and the Office of Swiss Co-operation (BuCo, Burkina Faso) engaged, with these organizations of market-gardening producers, in a process of research-action in partnership, being articulated around the experimentation of the drop by drop irrigation system.

This activity of research-action is based on a common ethical vision according to which, in the dynamics of the technico-social or socio-technique change, a technology is not adopted for what it only brings, but also for its capacity of adaptation to the real socio-economic conditions of these users. More than techniques, the social, societal and economic dimension,

must be put at contribution in any action aiming at fighting against food insecurity and poverty, for an improvement of the quality of their life.

The analysis of the data of the first cycle of production reveals a gross margin of benefit higher than 130 000F according to the speculation and decisions' of the owner, for surfaces of 500 m² and durations of 3 months average production.

Key words: research-action, participatory development of technologies, drop by drop, market gardening, institutional convergences, Co-construction of the innovation

Informal irrigation vis-a-vis the official project around the Bagre Lake (Burkina Faso) - Yameogo Lassane et Zougrana Tanga Pierre.

In Central-East of Burkina, on the middle course of the Volta River, the construction of a large dam in 1992 raised a great hope for rice production through the development of irrigated perimeters in total control. After promising beginnings the rice project underwent a period of crisis due to the recurring question of rice marketing and especially to the will of the State to disengage from the agricultural sector in order to leave the initiative to true stakeholders. Can't the withdrawal of the State constitute an opportunity for the territory of initiating new strategies of hydraulic territorialisation? Downstream the dam just like upstream, the local stakeholders seized this opportunity to initiate new strategies of valorization of the hydro-agricultural potentialities; these include summary irrigation methods which appear very dynamic with regard to the results. In which framework informal irrigation could form part of the official project downstream? Which are the strategies developed by the stakeholders upstream for the implementation of small scale irrigation? Which are the future prospects for development of informal irrigation around the Bagré lake?

This study aims at appreciating the space differentiations of the new strategies of hydraulic territorialisation between the downstream and the upstream of the Bagré dam. To achieve this, the proceeding consisted of observations, analysis of stakeholders' actions and strategies between upstream and downstream.

The study concluded that:

- The crisis of the official project made it possible to the stakeholders to initiate new strategies of territorialisation
- The relative decline of the official project downstream made it possible to stakeholders to introduce a much more flexible informal irrigation;
- A the upstream populations benefited from the construction of the reserve lake to reinforce their activities and to tie new relations with the institutional stakeholders.

The results make it possible to take into account decisions tending to soften the strategies of interventions of the official projects to enable non- project initiatives (informal irrigation) to form part of the great project.

Formal and informal irrigation for the dry season production in Burkina Faso: statistical reality and development potential. S. Sanfo, M. Kaboré et B. Barbier.

The burkinabé peasants are on the way to carry out a small agricultural revolution starting from a few hundreds of small earthen dams built after the great drynesses of the Seventies and Eighties by the government and the NGOs. A few hundreds of thousands of small farmers settled around these water points, downstream and upstream the dams to produce rainfed rice and dry season cultures such as onions and tomatoes. Intended for the domestic market and export, these speculations take a remarkable economic importance.

The national data bases were analyzed to evaluate the operation of these systems of production and their performances. A space analysis clarifies certain determinants of the development of this production in certain areas. The results show that the production is generally organized in an informal way with a relatively loose support of the state. The reasons of the success of this dry season production are to be sought in the lack of alternatives for the peasants for whom lands became rare during the rainy season and for whom the possibilities of emigration are restricted. The study makes it possible to call into question a certain number of generally accepted ideas and enables to make proposals to support the development of a dynamic but relatively fragile sector.

Some donors' experiences on informal irrigation in Africa – H. Léville, T. Stephens

In Sub-Saharan Africa, informal irrigation represents an important percentage of the total irrigated surfaces. Although data remain very imperfect, this notion of informal irrigation seems to receive more and more attention from donors. Indeed they wish to recognize the weight this hidden economy and undoubtedly they often see it as an opportunity within the framework of the Millennium Development Goals. We would like to examine in this paper three following issues:

1) Are the main donors in the continent (such as African Development Bank, World Bank, IFAD, and European Union, bilateral) conscious of the importance of the topic after the recent scientific publications on the subject, in particular from IWMI or FAO? What is their level of awareness and what could be their position on that matter? It looks like that donors' interest has evolved with time. Twenty years ago the focus was on the problem of feeding the cities (street markets). Then the attention shifted to re-use of waste water, which is not any more a taboo but still requires a great prudence. Recently the interest for this agriculture seems to be around the economic opportunity within the framework of poverty reduction. Finally there is also relevance to help marginal farmers to adapt to natural resources competition and environmental degradation.

2) What is the perception amongst stakeholders (notably national governments and NGO's) of informal irrigation, its importance in agricultural production, its recognition vis-à-vis more formal "structured" irrigation and its potential for development in the future? What are the difficulties encountered by national governments in order to tackle the problem of informal irrigation? Indeed some governments seem to be pioneers on the question when they are setting up specific funds in order to support the informal economy (Burkina Faso, Cameroon).

3) The third question is more pragmatic. Can we learn from existing experiences, recent projects on "informal" irrigation? One will describe some cases studies including a large range of actions such as: data acquisition, training, adapted micro credit, supply of equipment, support for marketing, land tenure etc... From these examples could we draw some lessons on how to design irrigation projects for marginal farmers? Finally how can we help irrigation departments play an active role in implementation?